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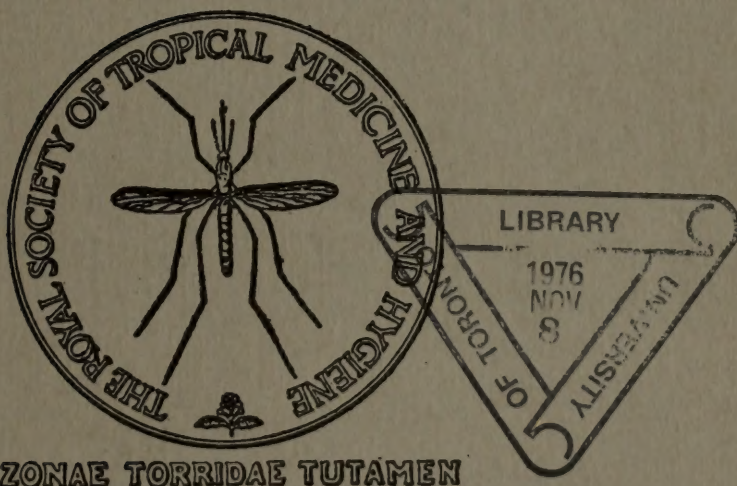
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TRANSACTIONS
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Proceedings of a Meeting of the Society held on Thursday, 15th November,
1923, at 8.15 p.m., at 11, Chandos Street, Cavendish Square, W. 1,
Sir PERCY BASSETT-SMITH, K.C.B., C.M.G. (*President*), in the Chair.

YAWS IN KENYA COLONY.

BY

J. L. GILKS, F.R.C.S., Edin.

P.M.O., Kenya Colony and Protectorate.

It is with considerable diffidence that I am addressing the Society on the subject of "Yaws in Kenya Colony," as I am conscious of the fact that I have little or nothing new to communicate. It may, however, be of interest to Fellows to hear of the extent to which the disease exists with us and the steps which are being taken to combat it, and it will be realised that the disease is one of great economic importance to the colony.

It is not my intention to give a description of the clinical aspects of the disease, though the lantern slides which will be shown later on will serve to illustrate many of its manifestations.

Present Incidence.—It may be said that yaws is met with in almost all parts of the Colony and Protectorate, though it is, undoubtedly, not common among the areas of European settlement and in the towns, possibly due to the fact that in these areas European clothing is more often adopted, while the native population is largely composed of those who are or have been in employment which they would not be able to obtain or retain if suffering from

the outward manifestations of yaws. In the native areas yaws is exceedingly prevalent in the following localities:—

1. On the coast from Shimoni to Malindi, and for an unknown distance inland.
2. In the Tana Valley.
3. In the South Kavirondo district.
4. In the Central Kavirondo district.
5. The Fort Hall, Embu, Meru and South Nyeri districts of the Kenya Province.

Native evidence as to the incidence of the disease, where it is now prevalent, is to the effect that such has existed among them for as long as they can remember, and in only one district, viz., Central Kavirondo, is it stated to have decreased.

The earliest available medical report of the country describes cases of extensive shallow ulceration, which we now recognise as a form of tertiary yaws while the Uganda report of that year records yaws as being present. In those days, Uganda included a large strip of territory which was afterwards handed over to the then East Africa Protectorate.

From 1905 onwards, yaws is mentioned in every one of the reports.

We have little information on which to work out a percentage of the population affected in any of the districts in which yaws is prevalent. It has been stated that from 60 to 90 per cent. of the population in the Fort Hall district suffers or has suffered from yaws, but there are no figures to support this, though it may be true. It is no uncommon thing for natives in this district to say that every baby has yaws. We do, however, know a few facts. During 1922, 6,616 cases of yaws were treated in the Fort Hall district, the estimated population of which is 187,609, that is to say, over 3·5 per cent. of the population presented themselves for treatment on account of this one disease.

Again, in the Central Kavirondo district, where the prevalence of yaws is undoubtedly much less than in the Fort Hall district, a survey of 7,933 persons, adults and children, as to their physical condition, revealed the fact that 278, or 3·5 per cent., suffered from yaws. It is probable that at least 60,000 persons in the country require treatment for yaws at the present time.

Influence of Race, Climate and Altitude.—It does not appear that either race or altitude has any influence on the prevalence of yaws. Both the Nilotic and Bantu races are affected, and cases have occurred among Europeans and Indians.

In South Kavirondo there is a sharp limitation, in that the disease is almost entirely confined to the Nilotic Jaluo; the Kisii, a Bantu race, being comparatively free, while in Central Kavirondo both the Nilotic and Bantu stocks are affected. The Kikuyu, among whom the incidence is very high, are of Bantu origin.

The disease is common both at sea-level and altitudes of 5,000 feet.

There is a certain amount of evidence that temperature and climate have a bearing on the incidence of yaws. I have already mentioned the fact that the disease, in South Kavirondo, is almost entirely confined to the Jaluo, and

these inhabit the warmer and drier country round the border of the lake. Among the Kikuyu it has been noted that the disease is more prevalent among the warmer and lower-lying localities.

Mode of Infection and Spread.—It would appear that the disease is spread usually by direct contact with an infected person, or by contamination of abrasions and ulcers by flies, who convey the infection mechanically. Contact with infected clothes and utensils probably also is of importance. It is, of course, not impossible that conveyance of the disease may occur through the agency of blood-sucking insects, but so far there is no evidence of this, and the conditions under which the native lives in the reserves afford excellent opportunities for the spread of disease by simple transmission. The huts are dark, warm, unventilated, and dirty, and overcrowding is prevalent.

In the *Proceedings of the Royal Society of Medicine* for June this year, is an account by POWELL of the spread in India among coolies of yaws when it was first introduced from Ceylon. It can be easily realised from this that the disease may, if unchecked, very rapidly affect whole populations, and this has apparently occurred in Kenya.

There is no reason to think that the disease is transmitted congenitally, and in this our observations agree with those made in other parts of the world.

Diagnosis.—The disease with which yaws is most likely to be confused is, of course, syphilis, and the matter is frequently one of considerable difficulty where the tertiary manifestations are concerned. In the primary and secondary stages the yellow, crusted granulomata are characteristic, and but little difficulty as a rule occurs, though, when the lesions are few in number, and situated in the axillæ or internatal folds, they assume an appearance very similar to condylomata. The tertiary lesions of yaws are not distinguishable from syphilis, and laboratory tests are no help. The Wasserman test gives a positive result in both diseases, and SPITTEL records that the luetin test was positive in 50 per cent. of secondary and 77 per cent. of tertiary cases. The differential diagnosis between tertiary yaws and syphilis, therefore, rests on the history of the case and the presence or absence of syphilis in the district from which the patient comes. In Kenya, as in other parts of the tropical world, syphilis is an urban disease, while yaws occurs among the more primitive inhabitants of the out-districts. A patient suffering from tertiary ulceration, or his friends, will usually remember his primary or secondary lesions, which are well recognised by the natives themselves.

Treatment.—Up to recently, the line of treatment adopted has been the administration of novarsenobillon, either intravenously or intramuscularly, with the application of simple dressings to the larger ulcers. The results of the administration of N.A.B. on the majority of the cases have been astonishing, and the cutaneous manifestations are frequently healed in a few days (five to seven). In tertiary cases healing is much slower. We have endeavoured to give at least two injections, with an interval of ten days, to each patient, but the astonishingly quick healing produced by the drug in cases of secondary yaws has too often prevented this being done. The native, because his sores are healed, imagines himself cured and departs for his village.

Antimony has been tried but appears to have no action.

Prior to the end of the war, neither funds nor staff were available to grapple with the problem of yaws, nor, owing to conditions in the country, were medical officers stationed in the reserves generally, so that, to a very large extent, the high incidence of the disease was not realised. Since the war, conditions have changed, and it has become possible to take measures against the disease. Medical centres have been started in the reserves and provision was made in 1921 and 1922 to obtain large supplies of novarsenobillon. A special yaws camp was started in the Kikuyu reserve on the lines of a similar institution run by a mission in the district.

The success of these measures is indicated by the number of cases which have presented themselves for treatment, and which are as follows:—

1918	...	...	325
1919	...	...	639
1920	...	...	657
1921	...	...	7,401
1922	...	...	24,233

The success of the novarsenobillon treatment in itself proved an embarrassment in 1922, as the cases flocked in in such numbers that it was evident that financial conditions would not allow of sufficient provision of novarsenobillon, and it was necessary, therefore, to institute the payment of a small lump-sum fee by patients, partly to cover the cost. This step, though insuring the continued attendance of cases who paid the fee, resulted in a large falling off of the total number, and in several districts this did not recover itself. Fortunately, we have been able to avail ourselves of another drug, which has proved equally as efficacious as N.A.B. in treatment and is infinitely cheaper, namely, the bismutho-tartrate of sodium and potassium. We are indebted for this to Dr. ANDREW BALFOUR, who first drew the attention of the Medical Department to the fact that the bismuth salt was being used with success in the Tanganyika Territory, and to Dr. SHIRCORE, the Deputy P.M.O. of Tanganyika, who kindly supplied us with all the information at his disposal with regard to the use and preparation of the drug. The Director of the Chemical Research Department in Kenya has devoted a large amount of his time to the question of the manufacture of the salt, and now furnishes us with a supply at the cost of one-tenth of a penny per dose, which, of course, is based merely on the cost of the materials.

The salt which we use has a bismuth content of 54·5 per cent. and therefore differs slightly from "trépol," which has a bismuth content of 64 per cent. A full account of the preparation of the salt will be found as an appendix to the Annual Report of the Bacteriological Laboratory for 1922. It was necessary, before adoption, to test the toxicity towards rabbits, and this was done with the result that a dose of 0·2 grams was decided on as being suitable for adults. The salt is stable, easily soluble in water, and its solutions can be boiled. It is desirable, however, that the solution be freshly prepared, as it has been found that it tends to develop a mould on keeping.

Administration is by means of deep intramuscular injection, and the reports as to its use have been unanimously favourable. There does not

appear to be more local reaction than is met with in the use of N.A.B. intramuscularly.

Caution must be observed in use in order to avoid stomatitis, which, in some cases, has been severe, especially when the recommended dose has been exceeded, or in cases already suffering from septic mouths

I can say very little as regards the ultimate result produced by giving cases one or two injections of N.A.B. or bismuth; it is certain that the lesions clear up very rapidly in most cases, but how often this is permanent we are as yet not able to say. A percentage of cases recurs, but as to how large this is we have no information as yet. We have not been able to test the result of treatment against the Wassermann reaction, and we do not even know whether it is desirable that treatment should be continued till the reaction is negative. In the *Philippine Journal of Science* for March, 1923, GOODPASTURE and DE LEON give some account of the result of treatment of yaws with N.A.B. on the Wassermann reaction, from which it appears that the reaction weakens very considerably or becomes negative after one injection, also that the weakening is progressive, from which they recommend that the guide in carrying out mass treatment should be the complete healing of the lesions.

Future Action.—Having at our disposal a drug, the cost of which is trifling, the next point to be considered is whether it is possible to eradicate yaws from the affected communities, and we are of opinion that this can be done. The problem might be tackled in three ways:—

1. By immunising the population.
2. By raising the general standard of sanitation.
3. By directly attacking the causal organism.

The first of these methods is not feasible, no method of immunising the individual having been devised.

The second method would almost certainly result in the desired end, but it is not reasonable to imagine that this could be brought about at any time in the near future, largely concerned as it is with economic and educational factors. Segregation of the sick would, doubtless, be useful, but when the disease exists to the extent which it does to-day, such is impracticable, and an attempt to force such on an ignorant native population is almost certain to result in concealment and so defeat its own ends.

The third course does appear to be practicable. If it is correct—and there appears to be little doubt that it is so—that the disease is caused only by direct transmission, the problem resolves itself into one of treating individuals who are in the infectious state, that is to say, those who have ulcerating lesions, and so reducing or eliminating the foci of infection. It is, of course, necessary that the operation be carried out simultaneously in a given district or area and every affected individual therein be treated.

The method which we are adopting at the present is to station dressers, specially trained in the administration of bismuth, in areas where the disease is common. The medical officer in charge of the district is equipped with motor transport and makes frequent inspection of the boys and their work, and with the help of the administrative officers and the chiefs it is hoped that

the majority of the affected inhabitants will in this way attend for treatment. It is probable that later on the system will have to be elaborated in order to insure that every affected person has received treatment and sufficient treatment, and it should be possible to effect this by instituting a system of yaws counters who would accompany the hut counters on their rounds and make a complete list of those persons still requiring attention. By the aid of the administration and the chiefs it should, thereafter, be an easy matter to insure the treatment of persons listed, either at the existing centres or at travelling dispensaries.

The system which has been described has only been in existence a short while, but the reports so far are distinctly encouraging, and it appears that the number of cases treated in 1923 will largely exceed even the considerable total for 1922, which, in itself, is a considerable testimony to the work being done by our limited staff of medical officers.

I am indebted to Dr. WENYON for the lantern slides, which will now be shown, and which were prepared at the Wellcome Bureau of Scientific Research, from photographs supplied to me by medical officers and other friends.

GRAPH showing the average number of Yaws Patients admitted per day per month since the Yaws Camp opened in November, 1921.

No. Nov. Dec. Jan. Feb. March. April. May. June. July. Aug. Sept. Oct. Nov. Dec.

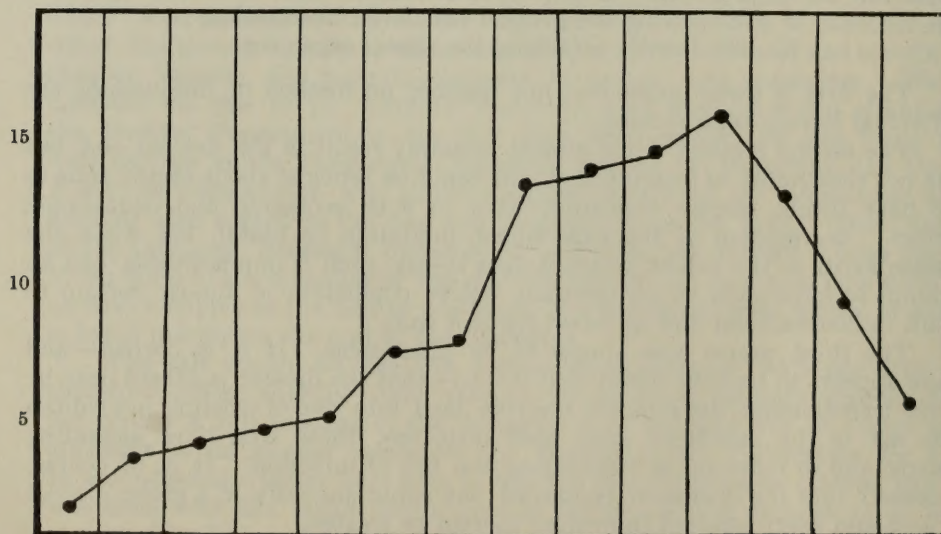


Chart showing the average number of new yaws cases per day per month which attended from the opening of a new centre in November, 1921; till the end of 1922. The drop coincides with the institution of a fee for treatment.

DISCUSSION.

The PRESIDENT: I am sure you will agree with me that we are very fortunate in having Dr. GILKS here to-night to give this most interesting description of yaws in the colony. One of the things which strike me particularly is that here you have an example of a disease introduced into a virgin country and running rampant. The people are in no way protected, and they practically all suffer. The necessity, therefore, for an organised method of fighting against the disease is very great, and, from what Dr. GILKS has said, it would seem there is a great want of a sufficient number of medical officers to cope with it satisfactorily. We want many things: one is to be able to find out how the disease is conveyed; is it conveyed by the flies? Has it been demonstrated that the flies are infected? And there is also more attention needed in the statistical work.

With regard to treatment, we have to find which is the more beneficial, the arsenic or the bismuth treatment. Looking at the awful specimens which the slides show, one wonders whether it is possible for those cases to be alleviated or cured after a few doses, such as one reads of in connection with yaws. I certainly do not see how that can be in the tertiary cases. Early cases are, no doubt, quickly benefited by treatment. It is said, in connection with the therapy of yaws, that in this the results are more conclusive to the native mind than in any other disease; there is a rapid curative result with a minimum of treatment.

There are many points of interest in the paper, and I hope you will discuss them.

Dr. ALDO CASTELLANI: I have listened with great pleasure to Dr. GILKS' address, which is a very important one from various points of view. First, there is the geographical distribution. Dr. GILKS has clearly demonstrated that the disease is present, and there are numerous cases of it, in districts from which it was supposed to be quite absent. I was interested in his remarks in regard to the influence of climate and altitude on the distribution of the malady. Apparently climate has not much influence on the distribution of the disease in Kenya. Our experience in Ceylon is somewhat different. Dr. MANSON-BAHR, Dr. CHALMERS and myself have, for instance, called attention to the fact that very few cases of yaws are found in the hills of Ceylon, while there are many in the low country.

With regard to the diagnosis, I agree with Dr. GILKS that in the secondary stage, and also in the primary stage, the diagnosis is, as a rule, extremely easy. There is a test to which very little importance has been attached—it is a therapeutic test. In cases of secondary yaws, when we are not quite sure whether a case is syphilis or yaws, the administration of mercury will often clear up the doubt. In my experience, and, I think, in the experience of all the observers who have actually treated cases of yaws in the tropics, mercury has absolutely no influence on that disease.

As regards the prevention of yaws, I am in complete agreement with Dr. GILKS that the disease is carried by contact, and very often by flies, but in a mechanical way, as, I venture to say, I demonstrated some years ago in

Ceylon.* Therefore, the measures outlined by Dr. GILKS seem to me to be very practical. Having a certain experience in the treatment of yaws, I think he will probably find the following difficulty. So many of these cases treated with salvarsan and neosalvarsan get well very quickly, but the cure is not real, only apparent. The infection remains latent, and after a period of time the lesions reappear. Therefore, for some time to come, there will be probably foci of infection, although the treatment may have been apparently quite successful. But that is only a minor point.

In conclusion I congratulate Dr. GILKS very warmly on his interesting paper..

Dr. A. POWELL: I have listened with the greatest interest to Dr. GILKS' address. I think elevation has this influence on the incidence of the disease, that the greater the elevation the colder the climate; hence more clothes are worn and less area of skin is exposed to wounds and abrasions. It is the experience of all countries that the primary sore is most often found on the lower limbs, which are nearly always naked in coolies and negroes. Like Dr. GILKS, I have found the bend of the elbow a common site for the primary yaw, especially in women, and have thought it due to the metal armlets they so often wear causing abrasions. The most striking difference between Dr. GILKS' cases and mine is in the proportion of tertiary lesions. I think he found about seventy tertiary to forty secondary cases, while I have seen about a thousand general eruptions and no tertiary signs, except in two cases who certainly had syphilis before contracting yaws. This is a very striking contrast. One explanation may be that I had not seen my cases long enough. The longest time I had a patient under observation was thirteen years; the average about seven. Yet our text-books maintain that tertiary lesions appear much earlier in yaws than in syphilis. If so, I should have seen some, as my observation was exceptionally close and continuous. My patients were nearly all indentured coolies, who were periodically inspected by myself and several keen assistants. Another explanation may be that the diagnosis in many of Dr. GILKS' cases was based on the statement of his negro patients, who were probably as illiterate as mine, and their dermatological qualifications no greater. Again, having been a medical jurist most of my life, I may require more legal evidence than other medical men. Dr. SPITTEL, the most recent author, says that it is on the personal history we must rely for a diagnosis of tertiary yaws. When we reflect that these histories are given by uneducated adult coolies or negroes, and that their alleged attack of yaws took place when they were babes or young children, I think all lawyers will agree with me that "what the coolie said is not evidence." A sample of such "evidence" from one distinguished author is: a Carribean prostitute showed tertiary lesions when thirty-four years old. She said she had yaws when a suckling. Therefore the lesions were due to yaws. I also note that the luetin reaction is given as 70 per cent. positive in tertiary yaws, only 40 per cent. in secondary. This raises a suspicion that many of these tertiary yaws are really syphilis.

My treatment of yaws was before the days of "606" and before the

* CASTELLANI and CHALMERS' *Manual of Trop. Med.*, p. 1.556.

dangers of atoxyl were known. The latter drug was the most successful in my hands. My routine was 10 grs. hypodermically twice a week, and I have given many a patient 160 grs. and never had any eye symptoms, but occasionally there was vomiting and acute colic. It had the advantage of being cheap and painless in administration.

In 1896 I drew attention to the therapeutic effect of fever on yaws, a matter of interest in connection with the treatment of general paralysis with the malarial parasite. When prolonged high fever occurs from any cause in yaws cases, the eruption often disappears, but not always permanently. One intercurrent epidemic of severe measles caused a remarkable improvement in many cases of yaws. I first used living cholera bacilli hypodermically, but the fever was of too short duration to cause much improvement. I next used Coley's fluid, but found its action too uncertain, as a small dose sometimes caused severe and prolonged reaction; sometimes a large dose produced none. When there was high fever improvement usually followed, but the fluid was too unreliable to be safe.

The effect of fever on the *Spirochaeta pertenue* may offer some encouragement in the treatment of general paralysis, but, on the other hand, I must record that three weeks ago I found a patient with a very heavy infection of benign tertian parasites. I was about to send some of his blood to a colleague for treatment of a case of G.P.I., when I found the malarial patient himself had *tabes dorsalis*!

Dr. G. C. Low: Dr. POWELL has anticipated me somewhat in what I was going to say about the tertiary lesions we have seen in some of the photographs to-night. I agree with him that many of these are more like syphilis than yaws. How one can differentiate the one from the other is, I think, an impossibility. When I was in Uganda, in 1902, I only saw two cases of the disease, and yet I knew it intimately as I had seen it abundantly in the West Indies. In the latter place some of the doctors denied the existence of a definite primary sore, and certainly in many of the cases no "mother yaw" could be detected. Dr. CASTELLANI has shown that mercury and iodide have no effect on yaws, and that was our experience in the West Indies. When we got cases which responded to mercury quickly we concluded they were syphilis. At that time there was little or nothing in the way of treatment; the cases were isolated until they recovered, and, as far as I can remember, we did not get these terrible scarring effects which Dr. GILKS has shown us in his pictures. Probably the reason of this may be found in the fact that the patients were better looked after in regard to cleanliness, thus avoiding mixed infections.

Major E. E. AUSTEN: I would like to ask Dr. GILKS one or two questions in connection with the possible agency of flies as mechanical transmitters of yaws. It seems to me there is a certain practical importance in knowing, in the first instance, whether flies played an appreciable part in the transmission of yaws; and, secondly, if they do, what species of flies are concerned. I remember, many years ago, a fly being sent home from the West

Indies for determination, since it was thought that it might be concerned in the dissemination of yaws. Although that fly is common in many parts of the tropics, it was scarcely likely to be a carrier of the disease under discussion because, speaking from personal acquaintance with it on the Amazons, it is not attracted to ulcers and sores on the body. On the other hand, there undoubtedly are flies of a different kind which are in the habit of feeding on ulcers and lesions. These flies, though of different species, are all members of the group Muscoidea, that is to say, they are more or less closely allied to the common house-fly. If flies do play a part in the transmission of yaws, they will probably be found to belong to that group. Therefore, I would ask Dr. GILKS if he has made observations, or knows whether observations have been made, in order to determine the kind of flies which in Kenya most frequent wounds and the lesions of yaws; also if anyone has attempted to discover whether or not such flies actually contain the causative organism under natural conditions. If such investigations have not been made, I do not for one moment suggest that the (probably overworked) *medical* staff of Kenya Colony should undertake them. But there is or was a Government Entomologist in Kenya, and it seems to me that the researches in question might well be entrusted to this officer, if he still exists.

As I have already remarked, the matter is not without importance, because, although Dr. GILKS evidently thinks it hopeless to expect any general amelioration of sanitary conditions in Kenya within a reasonable time, yet if we knew what the species of flies concerned are, we could perhaps discover their breeding-places, and it might be possible to stamp out the latter locally, at any rate in the vicinity of yaws concentration camps. While the species of Muscoidean flies are exceedingly numerous, it is safe to say that the majority are indistinguishable except to the eye of a specialist. On the other hand, these species differ widely, not only in habits but also in their life-histories, so that, in connection with yaws, the accurate determination of the species of flies that may prove to be actual or potential carriers is of primary importance. If Dr. GILKS is able to obtain specimens of the particular species of flies concerned, and if he will send them home to the British Museum, they will be promptly identified, and particulars will be forwarded to him.

Dr. H. S. STANNUS: I congratulate Dr. GILKS and his staff on the campaign they are carrying out in East Africa. Several speakers have remarked on the distribution of yaws, and Dr. Low said that but few cases of the disease were seen in Uganda when he visited that country a good many years ago. I suggest that with extended opportunity a large number of cases would have been found. "If you look for a disease in Africa, you will find it," has often been impressed on me. When I first went to Africa, I was told that certain diseases did not occur, but it only wanted a little investigation to find the cases.

Dr. POWELL and Dr. Low have referred to "the illiterate savage" in speaking of the African native, and believe that their medical histories cannot be trusted. He may be illiterate and a savage, but he has a remarkably good memory, and often the history a native gives can be trusted to be accurate;

he often preserves a very accurate memorised knowledge of his family, for the very reason that he is illiterate.

I think Dr. POWELL said he watched three cases of yaws for thirteen years without tertiary lesions arising. I suggest that may not be long enough, and that tertiary yaws may occur twenty years after the primary lesion. The question of tertiary yaws as an entity is one which crops up every time the subject is discussed, also the differentiation of the disease from syphilis; and we are still waiting for the pathologist or the bacteriologist to give us some reliable means of distinction between the two diseases. I suggest that research in that direction might be carried out in Kenya. May we hope to see the staff there receive all the necessary help it may require, in order to tackle the problem.

Dr. P. H. MANSON-BAHR: I have been especially interested in the clinical aspect of the photographs shown; and, from what I have seen of yaws in the tropics, *i.e.*, the Pacific Islands and Ceylon, I should say that the lesions Dr. GILKS has shown and described are more extensive than those which anyone has observed elsewhere. That is, possibly, because in Kenya yaws is spreading in an unprotected community.

I presume from the appearance of some of the facial lesions shown to-night by Dr. GILKS, considers "gangosa" to be but a nasopharyngeal form of tertiary yaws.

I have appreciated the paper we have listened to very much indeed.

Dr. G. C. LOW: A propos of Dr. MANSON-BAHR's remarks, paraframbœsial lesions have been described in Fiji. Dr. HARPER has thought that cases resembling locomotor ataxia and general paralysis of the insane in Fiji were late sequels of yaws rather than of syphilis.

Dr. H. M. HÄNSCHELL: Dr. LOW has told us that he saw many cases of yaws in the West Indies. Yaws is not present, however, in the whole of the West Indies. In Barbados it used to be common, but, long before the days of salvarsan, it vanished, and for at least thirty years has been unknown. There is constant communication with yaws islands, and the house-fly is exceedingly abundant in Barbados. My sole experience of the disease consists of a few cases I saw at the hospital there in 1907. They were shown to me by doctors who knew the disease, having seen it in other islands, and the lesions had the well-known wet raspberry appearance. The patients had arrived a short time before from some other island. The Medical Officers expressed no alarm about these cases for the disease did not spread in Barbados. That I think is a fact which ought to be looked into. If there are any Fellows here to-night who have been recently in Barbados I hope they will support or correct me. One recalls that although throughout the West Indies there is much malaria, yet in Barbados there was, and is, none. This fact provided a clue to the transmission and prevention of malaria and was entirely neglected. Even now, that *Anopheles* can make no footing in the island has not met with any very satisfying explanation; and so with yaws, its disappearance in Barbados

has not received the examination it merits. I suggest the region for yaws research, in all its aspects, is Barbados and its neighbouring islands. Dr. GILKS has given us a very interesting paper: may I congratulate him and Kenya on the results of his work? My contribution to the treatment of yaws can be by way of analogy only, from my own experience of the use of bismuth in syphilis. That experience is not a vast one. During the last year I have treated nearly 400 cases of various types of syphilis with a suspension containing 96 per cent. of pure bismuth metal, with very good results. Dr. GILKS has obtained his excellent results with a salt containing 54 per cent. bismuth; that percentage was used at first for syphilis too, but is now given up. If, then, yaws requires much less of the drug to cure, or to make the patient non-contagious, I submit to Dr. GILKS that with 96 per cent. bismuth fewer injections would be needed, and these would have a higher curative value. As to toxic effects, I have failed, so far, to detect any in my patients, though many of these have been given over 3 gm. of bismuth in seven or eight weeks; except that with the 96 per cent. bismuth suspension stomatitis is an early trouble. Most V.D. clinic patients start with tartar and septic gums, but in these it usually requires over 1 gm. of bismuth before the blue line on the gums appears; at this point the gingivitis is mild and can be neglected if the bismuth injections are stopped. I have seen much oral sepsis in Africans in the Gold Coast and around Tanganyika. I can wonder only how much less, or more, than 1 gm. of bismuth, in how few injections, would be necessary to render a yaw sterile and not produce too severe a stomatitis at the same time.

Dr. GILKS, in reply, said: Dr. HÄNSCHELL remarked on the percentage of bismuth in the salt used. We have one or two things to remember in dealing with a population of African savages, and one is that a large majority of them suffer from a certain amount of stomatitis before they come to us for treatment. We have to make our bismuth preparation ourselves, so as to carry on our campaign as thoroughly as possible and the salt we have been using is the easiest procurable. There was a very exhaustive article in the *Journal Medicale de Paris*, by SIMON, in March last, and he described stomatitis coming on early after small doses of bismuth.

Dr. MANSON-BAHR referred to the gangosa. Everyone in the Medical Department of Kenya is of the opinion that gangosa is a symptom of tertiary yaws. The extensive lesions he remarked on have been described by Dr. HOWARD as occurring in Nyasaland.

The question of parasyphilis is, I think, a most interesting one. The whole subject is so confused because we have no means of differentiating syphilis from yaws; and until we get that, I do not think we can get much further on the question of parasyphilis. One of the slides showed a condition very much like a Charcot joint in the fingers, and if that is a true Charcot joint, then we do get parasyphilitic lesions. I hoped, on my present leave, to be able to find somebody who would put us on to some line along which we might pursue the differentiation of yaws and syphilis, but we have not yet got much further.

Before I came home, we discussed whether it was possible to produce

a body analagous to luetin, to see whether we could get a cutaneous reaction that way; but Dr. SPITTEL, in his book, refers to getting positive results with luetin. The figures, positive results in 50 per cent. of secondary lesions, 77 per cent. in tertiary lesions, were with luetin; it was not the Wassermann reaction. We found the Wassermann reaction positive in the enormous majority of both secondary and tertiary cases.

Major AUSTEN asked if we had been able to carry out any work on the fly; I am afraid we have not. We hope to have a medical entomologist there next year. There is a Government entomologist now, but he has been entirely occupied with agricultural entomology, and we have not been able to avail ourselves to a large extent of his services, though he has done an extraordinary amount of work for us in his off-time. If we get an entomologist of our own, we have many bits of work for him to do, and one is dealing with this fly question. Flies swarm round the dirty native huts and we have thought they were concerned mechanically in the transmission of yaws.

The whole thing is, I am afraid, rather unscientific, but we are doing the best we can with a small staff. There are many things one would like to know. The point raised by Dr. POWELL as to the tertiary lesions, and the number we get, is most important, and I admit we have nothing to go upon in diagnosing these numbers of cases as tertiary yaws, except this, that we find the numbers of primary syphilitic lesions, primary chancres, that attend for treatment in the areas where we get thousands of cases of yaws, is extraordinarily small and evidences of congenital syphilis are absent. One of the centres last year returned only two cases of primary chancre; that is a very important point in this connection.

I have to thank everyone present for having listened to me so patiently.

COMMUNICATIONS.*

THE PREVENTION OF PHLEBOTOMUS FEVER.

BY

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Phlebotomus, or Sandfly, fever is an acute specific fever, common in the Mediterranean littoral, caused by a virus, possibly a leptospira, conveyed to man by the bite of the midge, *Phlebotomus*, as a rule of the species *papatasi*, (Photograph 1). The disease is characterised by severe frontal headache; suffused conjunctivæ; flushed face; tender eyeballs; pains in the back, limbs, and eyes, especially with movements; tongue, white coated on the dorsum and red at the edges; sudden rise of temperature to 103° F. on the first day of fever, which falls by lysis on the third or fourth day; relatively slow pulse and a distinct leucopenia (3,000 per c.mm.) accompanied by a relative lymphocytosis. There is no mortality, but convalescence is often accompanied by considerable nervous depression.

This disease has been known to affect British Forces serving in the Mediterranean since the year 1799,^{1 and 2} and is chiefly responsible for the present high sickness rate of our troops serving in tropical and subtropical regions (see map). For this reason, in the spring of 1921, the Royal Air Force Sandfly Fever Commission was appointed to investigate the causation, prevention and treatment of that fever. Malta, where the disease is prevalent, was chosen as the best locality in which to carry out these investigations, the chief reasons being its isolation, freedom from malaria, and the relatively small chance of encountering epidemic jaundice, relapsing fever, and other tropical fevers when compared with such countries as Mesopotamia or India.

As a result of these investigations, the virus of phlebotomus fever has been shown to be transmitted from generation to generation of *Phlebotomus papatasi*. This may be effected in two ways. Either it is transmitted by heredity or the larvæ infect themselves in the breeding-grounds by eating the excreta or the dead bodies of the parent flies.³ It is definite that the infection of the fly takes place in the breeding-grounds, and it follows that prophylactic measures against the fever must be directed upon the fly, especially in such places.

*With a view to making the TRANSACTIONS more interesting, it is proposed to insert SHORT COMMUNICATIONS from Fellows relative to any matters of medical, sanitary or parasitological interest. It is felt that many Fellows in various parts of the world must be in a position to contribute short papers on these subjects, and the Secretaries will be pleased to receive any such from them.

A sound knowledge of the habits and habitats of the *Phlebotomus* is the keystone to successful prophylaxis. This insect, like many other pests of mankind, depends on organic matter to complete its life cycle; it is encouraged by filth, and, as with flies in general, so its prevalence is an index of the degree of cleanliness of any area. Consequently, the removal of its breeding-places will reduce automatically the prevalence of other insect pests.

Throughout the prophylactic experiments which will be described, every advantage was taken of any details already published regarding the life-history of the fly, as well as new facts which were gleaned during the course of the investigation. The accurate control of these experiments proved full of difficulty, as there were so many factors which influenced the breeding and viability of phlebotomi, and for which due allowance had to be made. Many of the prophylactic measures tried have been recommended by various writers in the past, but for the most part on inconclusive data or on purely theoretical grounds. The present aim has been, as far as possible, to test any measure before suggesting that it should be adopted.

MOVEMENTS OF PHLEBOTOMI IN INHABITED BUILDINGS.

A knowledge of the mode of invasion of buildings by phlebotomi, and of their movements, after entering, was required before any plan of action could be formulated. Briefly, the flies entered the buildings by apertures in the walls, through windows, doorways, ventilators or even cracks. This invasion took place roughly between sunset and dawn. There was no invasion during the hours of daylight, except on those occasions when a strong wind had blown for two or three consecutive days, confining the phlebotomi to their breeding haunts, when hunger apparently caused them to seek a feed of blood at the earliest opportunity.

Once the phlebotomi, attracted by the odour of man, had gained entrance to the building, they proceeded to investigate more closely the source of the emanation. The females remained in the lower levels of the room in quest of blood, while the males mounted the walls and collected near the ceiling to await the females for pairing purposes. When the females had fed, many mounted the walls and sought secluded spots, especially the corners of the ceiling, and hangings or fixtures on the walls; others escaped through the windows, doorways or ventilators, and retired to their breeding-grounds outside. From observations made on captive phlebotomi, and also from a critical examination of 300 flies caught at random in various parts of the camp, it was apparent that those flies which remained in the huts were capable of biting again after an interval of from one to five days; this interval depending upon such factors as atmospheric temperature, humidity, pregnancy, and amount of any previous blood-feed. Some phlebotomi, for example, would feed only once or twice during their life-time, while others fed on as many as twelve separate occasions. Gradually, after a period of about five to fourteen days, many of the females either escaped outside to lay their eggs, or else

oviposited in the hut and then died. The rest died either egg-bound or non-pregnant, inside or outside the building, within fourteen days. Death took place sooner in the males, usually within seven days. Each night the number of flies indoors was augmented by a fresh invasion from outside. Unless some precautions were adopted, an inhabited building became more and more densely infested with these pests as the *Phlebotomus* season wore on, due allowance being made for certain fluctuations in the number of phlebotomi from the natural causes already cited.

The prophylactic measures tried were:—

1. The destruction of the insect in its various stages.
2. The prevention of the flies from biting man.

SCHEME OF PROPHYLACTIC MEASURES ON WHICH EXPERIMENTS WERE MADE.

I. WAR ON THE INSECT IN ITS VARIOUS STAGES.

A. Abolition of the breeding-grounds (destruction of ovum, larva and pupa).

- (a) Broken ground.
 - (i) Levelling.
 - (ii) Rendering the surface impervious.
- (b) Walls and embankments.
 - (i) Facing.
 - (ii) Pointing.
 - (iii) Treating the surface (preservation).
- (c) Buildings.
 - (i) Pointing and repairs.
 - (ii) Treating the surface (preservation).
 - (iii) Removal of insanitary buildings.

B. Destruction of the adult fly by—

- (i) Swatting.
- (ii) Spraying.
- (iii) Fumigation.

II. PREVENTION OF BITING.

- (a) Removal of hiding places.
- (b) Nets.
- (c) Repellants.
- (d) Air currents.
 - (i) Natural—Winds.
 - (ii) Artificial—Fans.



1. Primary yaw at bend of elbow. A not uncommon site in women who carry an infected child on the hip and support it with the arm.



2. Primary lesions on breasts in nipple areas. Contracted from suckling a child with secondary lesions around mouth, as shown. Primary lesions in this situation frequently result in destruction of the nipple.



3. Primary yaw on epigastrium, showing the large size and flattened appearance, with daughter yaw in close proximity, and secondary eruption on face.



4. Tertiary ulceration with destruction of nose and face.



5. On left, secondary eruption on face, showing circinate appearance sometimes assumed. On right, tertiary ulceration and destruction of nose. The left nipple has been destroyed, probably as a result of primary infection in that situation.



6. Extensive scarring as a result of tertiary ulceration resulting in contraction of elbows and left knee.



7. A case of generalised tertiary yaws, with dactylitis and deformity of fingers, sabre tibiae as a result of chronic periostitis, ulceration in region of breast and scarring of arm and forearm.



8. Secondary eruption on face, neck, and chest.

EXPERIMENTS BEARING ON PROPHYLACTIC MEASURES AGAINST
PHLEBOTOMI.

I. WAR ON THE INSECT IN ITS VARIOUS STAGES.

A. ABOLITION OF THE BREEDING-GROUNDS.

In order to test, as far as possible, the effect of measures undertaken to abolish the breeding-places of the flies, that portion of the camp which contained the men's quarters was divided into two parts (Chart 1). It was decided to treat the half which, during the earlier rounds of inspection, had contained the greater number of flies. Accordingly, work was commenced on this, the westward half, on the 12th June, 1922.

The measures taken were as follows :—

(a) *Broken Ground*.—(i) The ground surface was levelled, where necessary the surface was built up with road metal, and all pits and hollows filled in. The surface was then rolled with a heavy roller. Particular care was taken to ensure that the ground adjoining walls and buildings was properly rammed home; most of this part of the work was done by hand with iron rammers. (Photographs 2 and 3.)

(ii) Tar was used as a surface dressing to render the ground impervious and thus unsuitable for oviposition, larvation and pupation. Although, possibly, it was not the best dressing, it acted very effectually. The only trouble was due to imperfect rolling of the ground and failure to brush the surface free from dust before the tar was laid. In these circumstances the surface layer of tar peeled off in a short time.

The tar was poured out from watering cans, and spread by means of yard brooms; this cumbrous method was used as no spraying apparatus was available.

(b) *Walls and Embankments*.—(i) Where necessary, instead of leaving loose banks between different levels of the ground, sufficient of the bank was cut away to render a uniformly vertical surface, which was then faced with a stone wall, crevices between the stones being carefully filled in (Photographs 4 and 5). This was necessary as phlebotomi were frequently found resting in the crevices of banks and walls during the day time.

(ii) Existing walls were repaired and pointed. Many of these walls consisted of a double row of stones with loose earth in between, so that, unless the top of the wall as well as the face was closed in from the outside air, phlebotomi still harboured in them. The top of each wall was rendered impervious by a layer of cement, or else, after pointing, by the application of a good layer of tar.

(iii) In some instances tar was painted on the walls as a preservative; otherwise, the moist atmosphere caused the surface of the stone to crumble and crack, thus giving shelter to insects behind the crevices. (Photograph 5).

(c) *Buildings*.—(i) All buildings were similarly repaired and the crevices filled up; in many cases, although but recently erected, the walls showed large cracks in the cement. (Photographs 6, 7 and 8.)

(ii) Many of the walls were eroded, especially in the lower three feet of the buildings. This was due to dampness derived, in part, from the splashing up from the ground of condensation water which had fallen from the roof, and, in part, from the ground-damp absorbed by the very porous coralline limestone of which the walls were constructed. Probably, the action of the sea air aided the process. To lessen the chance of erosion, the walls were tarred above the ground level for a distance of three feet (Photograph 9).

(iii) An old wooden building used as a barber's shop, situated just north of the sick quarters, served as a refuge for insects. Owing to this, and because its presence interfered with the process of levelling, it was demolished. (Photograph 10.)

Although every effort was made to get this work pushed on as rapidly as possible, various setbacks delayed its completion. By the 8th August, 1922, these prophylactic measures had been applied around and for a distance of 15 yards beyond the huts in the westward half of the camp, except at the north-west corner, where some broken ground was unfortunately not efficiently treated during the fly season.

The number of phlebotomi in the huts was estimated daily by counting the flies in the four corners of each hut at sunset. After the counting was completed the flies were killed by swatting. In this manner the daily counts gave an indication of the rate of breeding of the phlebotomi in and around the camp, and also their power of invading dwellings. During the experimental period every hut in the camp was treated in the same way by daily swatting. The only difference was that, in the westward half of the camp, the walls of the huts and the surrounding ground and embankments were dealt with as described above, while the eastward half of the camp was not treated in this manner.

The *Phlebotomus* incidence in the westward, and subsequently treated, part of the camp (Chart 2, continuous line) rose rapidly in the early days of June. A similar, though less marked, rise occurred in the eastward part of the camp (broken line in Chart). During the week immediately following the institution of the prophylactic measures (17th to 24th June) there was a marked drop in the number of phlebotomi in the treated half of the camp. This fall, however, was not due to these measures, but to the north-west gale which blew from the 18th to 22nd June. The gale naturally effected the exposed western half more than the eastern half of the camp. This was confirmed by the rise in the *Phlebotomus* incidence which occurred during the following week. From the 22nd July to 5th August, the number of flies in the whole camp was markedly diminished. This was a natural occurrence, due to the phlebotomi hatching out in two waves, which reached their maximum height in the early and late summer respectively, the second wave being normally greater than the first. The prophylactic measures were almost finished in the westward portion of the camp by the 8th August. After that date the number of phlebotomi in this treated part of the camp was nearly always less than half that obtained in the untreated part. Strong north-west winds blowing on the 17th and 25th August accounted, to a certain extent, for the fall in the fly curve in the western half of the camp during the

period 19th to 26th August. It may be assumed that, had these strong winds not occurred, the fly incidence (continuous line) would have been represented by a line joining the points 12th August and 2nd September.

The striking facts were the large primary and small secondary wave in the treated, and the large primary and the larger secondary wave in the untreated half of the camp. In short, the result of these prophylactic measures was a marked reduction in the number of phlebotomi in the treated portion of the camp.

The results obtained in this experiment were somewhat vitiated, partly by the difficulties encountered in getting the work concluded, and partly because only a comparatively small area could be treated. Nevertheless, it was obvious that the principle involved was correct.

B. DESTRUCTION OF THE ADULT FLY.

(i) *Swatting*.—Various methods of swatting the flies were tried. The method which was found to answer the purpose best consisted in the use of a damp cloth.

Strips of cloth measuring 12in. by 24in., and of a fairly stout, pliable material were used. Ordinary surgical lint served the purpose excellently, but had to be renewed rather frequently, as it wore out after a few weeks' use. The cloth was made into a loose roll, the two ends of the roll being brought together and grasped. The free (striking) end was immersed in water for a minute or two and then gently squeezed to remove the excess of moisture.

With this weapon it was possible, after a little practice, to cause considerable destruction of the flies. The water rendered the end sufficiently heavy to give a smart blow, while, owing to the pliable nature of the material, it flattened itself well against the surface to which it was applied and killed any fly with which it came in contact.

As has been explained, the daily counts of the phlebotomi in the camp were made by estimating those in the corners of the huts only. It had been ascertained that, in any hut in which the men's kits were left lying on the shelves above each bed, the total count in the four corners approximately equalled that in the rest of the room. However, when all the kits were removed and no clothes allowed to lie about during the daytime, the number of flies in the corners greatly exceeded that found in the remainder of the hut.

To simplify the work, and because the counting of the flies was confined to the corners of the huts, only those flies occupying the corners were swatted. At times a few escaped by hopping towards the middle of the hut, but with daily and conscientious swatting the number that escaped was negligible.

Two ladders, each 8ft. long, were used to reach the flies at the ceiling level. The process of swatting was a somewhat arduous task. It took a party of five persons between one and a half and two hours to complete the round of twenty-eight huts. Even then, only the corners of each hut were treated.

The reduction in the incidence of phlebotomi which was obtained as a consequence of swatting was very satisfactory (Chart 3).

During the first sixteen days of the observations the corners of all the huts were treated daily by swatting, and Hut A4 was, if anything, less troubled by flies than the others. The corners of A4 were swatted until the 5th June. After that date, no treatment was used in that hut until the evening of the 28th June. Meanwhile, the flies in the other huts were swatted daily, at sunset, after they had been counted. The result was that the number of phlebotomi in A4 rapidly increased, and it was only for a short period, while a strong wind was blowing, that the number approximated to that appertaining in the treated huts. When this hut did not receive treatment the flies were usually four or five times more numerous in it than in the other huts.

In order to test further the efficacy of this method, swatting was recommenced in Hut A4 after the flies had been counted on the 13th July, and an immediate drop in their number was very evident. Moreover, the reduction was maintained as long as the swatting was in progress (14th to 22nd July), but the number shot up again immediately it was discontinued.

(ii) *Spraying Experiments.*—Various observers have recommended the use of sprays for the destruction of the adult phlebotomi. Several kinds of insecticide have been recommended, usually one of the commoner fluid disinfectants which are on the market. Little attempt has been made by experiment to prove the value of spraying, or to show which solution was the most effective.

Certain observations which had been made on fumigants (*vide infra*) had a distinct bearing on these experiments. It was found that phlebotomi possessed considerable powers of resistance to the emanations of various disinfectants; with some they even withstood the odours of a full strength solution for a time. Further, spraying had to be carried out when the men were sitting about in the hut. Therefore, to be of any practical value, the substance had to be capable of killing the flies when used in dilute solution. As the flies could resist the odours of the pure insecticide for some period, it was obvious that, to be effective, it was necessary to spray them directly with the fluid used.

To estimate the part played by the disinfectant and that played by the diluting fluid it was first necessary to conduct experiments with water alone. When studying the habits of the flies it was found that they, particularly the males, were readily killed by direct contact with a drop of water.

In order to throw some light on these points two series of spraying experiments were performed:—

(a) On a small scale in the laboratory.

(b) On a large scale in Hut A4.

(a) *Small Scale Experiments in the Laboratory.*—For these experiments a glass jar about 6in. in diameter was covered with a butter-muslin cover. Through this cover was a tube of muslin, similar to that used by WATERSTON for introducing phlebotomi into breeding pots.⁴

The phlebotomi were introduced into the jar and then sprayed by means of a fine nasal spray, the nozzle of which was held inside the tube of entry. As it was found that the flies flew against the muslin cover, where the spray could not reach, a second spray was used at the same time to play through the muslin.

Various disinfectants were tried; each being sprayed into the jar for a known period and the effect on the contained flies noted. Fresh flies were used for each experiment and the jar was thoroughly dried out before using it again. The method was undoubtedly very rough and difficult to control accurately, but the experiments, which were repeated several times, gave closely similar results on each occasion. The experiments performed on the 2nd August, 1922, with a room temperature of 81° F., gave the results depicted in Table I.

TABLE I.

No. of Experiment.	Fluid used.	Percentage strength of fluid.	No. of sprays used.	Duration of Spraying.	No. of flies Experimented on.	Results.
1	Water	—	2	40 secs.	3 males 3 females	1 male alive
2	Cresol	1	2	20 secs.	3 males 3 females	1 female alive (moribund)
3	Formalin	1	2	20 secs.	3 males 3 females	All alive

(b) *Large Scale Experiments in Hut A4.*—Experiments with a large spray, of the Meyer's knapsack type, were carried out in Hut A4 on several occasions between the 28th June and 16th August, 1922. In order to reach all parts of the hut, several yards of stout pressure tubing were necessary to connect the reservoir and the nozzle of the spray. (Photograph 11.)

The spraying was done very carefully and methodically, so that all parts of the walls and roof came under treatment. Special attention was paid to the wall ventilators and to the space behind and under lockers. The flies in the whole hut were counted immediately before spraying was commenced. When the spraying was finished, only one or two flies could be seen. This did not necessarily mean that all the flies had been killed, for, if the men's kits had been left on the shelves, a certain number sought refuge in these or similar hiding-places. The importance of rendering such hiding-places as few as possible could not be over-estimated, if the full effect of the spraying was to be obtained.

The fluids used for spraying were sea-water, one per cent. cresol solution, and one per cent. formalin solution, with the results tabulated in Tables II and III.

The phlebotomus incidence in Hut A4 (Chart 3), showed only slight daily fluctuations, unless some special treatment was administered. The marked drop in the number of flies was very obvious whenever spraying was carried out in the hut.

The first experiments (Table II, Experiments 1, 2 and 3) consisted of a series of sprayings with cresol, which were done on three consecutive evenings. On the first two evenings part only of the hut was sprayed; on the third evening the whole hut. There was a steady daily decrease of the

fly count as a result of the three sprayings; at the end of the third day the number of flies had decreased by 174, that is, from 220 to 46 (Chart 4).

Isolated daily spraying of the whole hut with cresol caused, on each occasion, a marked drop in the number of flies (Table II, Experiments 4, 5 and 6, and Table III, Experiment 4).

The effect of spraying with water alone was much less than after using an antiseptic solution (Table III, Experiment 1). Considerable numbers of flies could still be counted immediately after the spraying. There was little decrease found in the numbers of phlebotomi ten hours after treatment. A fall did occur in the count taken 24 hours after spraying, but this was probably due to the increased force of the wind.

The infusion of pennyroyal, *Hedeoma pulegioides* (Table III, Experiment 2), was more effective than the water, but not nearly so destructive to the flies as the cresol solution.

The same might be said of the results of spraying with formalin (Table III, Experiment 3). There was a distinct decrease in the number of flies, but not so marked or so lasting as in the case of cresol.

Of the fluids tested, cresol was the most potent. The lethal action on the phlebotomi was, to a certain extent, due to the water added, but experiments showed that the action of water alone was only a small one. The chief factor was some property inherent in the disinfectant itself.

In the experiments with fumigants (*vide infra*) the vapour of formalin was found to be far more efficient than that of cresol. This led to the supposition that formalin would make the more efficacious spray (MARETT⁵ and NEWSTEAD⁶). The marked superiority of cresol in the present series of experiments must, therefore, have been due more to physical than disinfectant action; its oily nature probably damaged the wings and respiratory system of the insect more than a watery solution.

From these experiments it was concluded that spraying was a most valuable weapon, and that the substance to be used should be of the nature of an emulsion rather than a watery solution.

(iii) *Fumigation*.—Although it was realised that this process was not of much practical value, except on a small scale or in private dwellings, various experiments were conducted in order to determine its efficiency. The drawbacks pointed out by NEWSTEAD were that the method was too expensive, and, if a good concentration of gas was to be obtained, too laborious.

Attempts were made to ascertain the insecticidal power, if any, of certain of the commoner disinfectants. In the first experiments, plugs of cotton-wool were soaked in various strengths of the disinfectant. Each plug was inserted into the bottom of a broken test-tube, and covered by an india-rubber cap to prevent the fumes escaping to the exterior. A thin layer of wool was then placed in the middle of the tube to partition it off into two chambers. The phlebotomi were introduced at the top end and kept imprisoned by a cotton-wool plug. By this arrangement it was hoped to prevent the flies from coming in contact with the disinfectant. It was found, however, that the flies tended to get entangled in the cotton-wool partition, where they died, in part, at least, from damage to their delicate wings.

TABLE II.
PRELIMINARY SPRAYING EXPERIMENTS WITH CRESOL.

No. of Experiment.	Date	Average Temperature for the day in degrees Fahrenheit.	Average Relative Humidity for the day.	Wind and Force.	Number of Phlebotomi in the four corners			Remarks.
					Before starting Experiment.	24 hours after Spraying.		
1	28/6/22	77.0	76.5	W1	215	157		Two corners sprayed only
2	29/6/22	78.0	77.0	NW2	157	111		Half the hut sprayed
3	30/6/22	78.5	76.5	NW2	111	46		Whole hut sprayed
4	3/7/22	76.0	77.5	WSW1	124	20		" " "
5	7/7/22	77.6	75.0	W2	186	40		" " "
6	10/7/22	77.6	86.6	E1	140	20		" " "

This table shows the marked reduction in the number of phlebotomi in the hut after one spraying with 1 per cent. cresol solution. The whole of these experiments were conducted at 7.30 p.m. on each of the respective days.

TABLE III.
SPRAYING EXPERIMENTS.

No. of Experiment.	Date.	Time.	Average Temperature for the day in degrees Fahrenheit.	Average Relative Humidity for the day.	Wind and Force.	Solution.	Percentage Strength.	Number of Phlebotomi in the whole hut				
								Before starting Experiment.	10 hours after Spraying.	24 hours after Spraying.	34 hours after Spraying.	48 hours after Spraying.
1	10/8/22	7.30 p.m.	87.0	43.8	N1-2	Sea-water	—	158	171	105	103	—
2	12/8/22	9.30 a.m.	85.6	50.8	N1	Infusion of Pennyroyal	7*	103	36	80	58	92
3	14/8/22	..	85.0	76.0	Calm	Formalin	1	92	40	100	89	118
4	16/8/22	..	84.5	62.5	NW2	Cresol	1	118	6	27	21	95

* The infusion of pennyroyal was made by boiling a quantity of the dried crushed plant in half a gallon of water. The resultant infusion was diluted 1 part to 13 of water and this was used for spraying.

To obviate any mechanical damage to the flies, the following apparatus was devised (Fig. 1). Two broken test-tubes, $\frac{3}{4}$ in. in diameter, were taken; one was about 5 in. long and the other about 2 in. One end of the longer tube was closed by a piece of phlebotomus-proof muslin and held in place by a piece of rubber tubing, which also served as a joint between the two tubes. Several flies were introduced into the longer tube, a cotton-wool plug was inserted, and the end of the tube covered by a rubber cap to prevent the vapour of the disinfectant from escaping. Into the open end of the smaller tube was put a cotton-wool plug soaked in the disinfectant; this end was then closed with a rubber cap.

APPARATUS FOR TESTING THE ACTION OF FUMIGANTS ON PHLEBOTOMI.



Figure 1.

- A. Test-tube containing phlebotomi.
- B. Test-tube containing fumigant under test.
- C. Butter-muslin partition.
- D. India-rubber tubing forming joint between the two test-tubes.
- E. Cotton-wool plug moistened with fumigant.
- F. Cotton-wool plug.
- G. India-rubber caps to retain fumes.

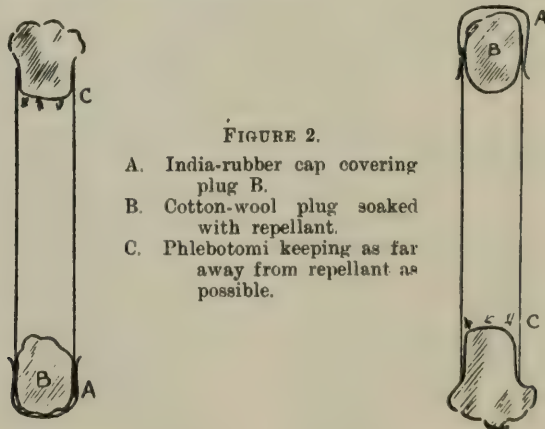


FIGURE 2.

- A. India-rubber cap covering plug B.
- B. Cotton-wool plug soaked with repellent.
- C. Phlebotomi keeping as far away from repellent as possible.

In the first three experiments of the first series (Table IV, Experiments 1, 2 and 3) the insecticide was used in a strength of 1 in 20. It was soon found, however, that this concentration was valueless under the conditions in which the insecticide had to act. The remaining experiments were, therefore, done with the full strength disinfectant.

Several series of experiments were necessary in order to test slight differences in the technique. Thus, in the first two series different positions of the

tubes were tried to allow any vapours lighter or heavier than air to act. In the third series an attempt was made to obtain concentrated action, while in the fourth the effect of increasing the humidity of the atmosphere was tried.

In each series the superior value of formalin over cresol, when used as a fumigant, was demonstrated. Even in the tubes where the formalin vapour was not left to concentrate, the phlebotomi were killed in three hours or less. It was only in the tubes with concentrated vapour that cresol seemed to have any effect (Table VI, Experiment 1); in all the other experiments with cresol no harm occurred to the flies. In fact, in a tube in which the effect of cresol vapour was being tried, a pregnant female laid eggs, which subsequently hatched out.

Apart from cresol and formalin the only other substance tested was turpentine. In the first three series of experiments turpentine had comparatively little action on the flies, but in the last series, in which the humidity of the air was increased, it had a distinct insecticidal action.

TABLE IV.

FIRST SERIES OF FUMIGATION EXPERIMENTS.

In this series of experiments the tubes were laid horizontally on the bench for the first 24 hours, while during the following period they stood erect, with the fumigant in the tube below and the flies in the tube above.

No. of Experiment.	INSECTICIDE.			NUMBER OF PHLEBOTOMI IN TUBES.					REMARKS.
	Name.	Percentage strength of.	Amount used in c.cs.	Before starting Experiment.	Alive after 1 hour.	Alive after 10 hours.	Alive after 24 hours.	Alive after 48 hours.	
1	Cresol	5	1	1 female	1	1	1	Nil	Killed by accident Killed by accident
2	Formalin	5	1	1 female	1	1	1	Nil	
3	Turpentine	5	1	1 female	1	1	1	1	
4	Cresol	100	1	1 female	2	2	2	2	
5	Formalin	40	1	1 male	1	Nil	—	—	Died in 24 hours
		100	1	1 female	1				
6	Turpentine	100	1	1 female	1	1	1	1	

The experiments shown in Tables IV to VII were repeated several times with closely similar results.

TABLE V.

SECOND SERIES OF FUMIGATION EXPERIMENTS.

Tube containing the fumigant was placed above the tube containing the flies, to allow any vapours heavier than air to act.

No. of Experiment.	INSECTICIDE.			NUMBER OF PHLEBOTOMI IN TUBES.					REMARKS.
	Name.	Percentage strength of.	Amount used in c.cs.	Before starting Experiment.	Alive after 1 hour.	Alive after 10 hours.	Alive after 24 hours.		
1	Cresol	100	1	1 female	1	1	1	Died in 3 hours	
2	Formalin *	40	1	1 female	1	Nil	—		
3	Turpentine	100	1	1 female	1	1	1		
* Full strength commercial solution.									

* Full strength commercial solution.

TABLE VI.
THIRD SERIES OF FUMIGATION EXPERIMENTS.
In this series the fumigants were left for ten days in sealed tubes to concentrate the vapours. After addition of phlebotomi the tubes were placed vertically, the fumigant in the tube below.

No. of Experiment.	INSECTICIDE.			NUMBER OF PHLEBOTOMI IN TUBES.			REMARKS.
	Name.	Percentage strength of.	Amount used in c.cs.	Before starting Experiment.	Alive after 15 minutes.	Alive after 1 hour.	
1	Cresol	100	1	2 females 3 males	5	Nil	
2	Formalin	40	1	5 females 2 males	Nil	—	
3	Turpentine	100	1	3 females 4 males	5	2	

TABLE VII.
FOURTH SERIES OF FUMIGATION EXPERIMENTS.
In this series of experiments both of the cotton-wool plugs were moistened with water to render the atmosphere in the tubes as humid as possible. Fumigant tube above, fly tube below.

No. of Experiment.	INSECTICIDE.			NUMBER OF PHLEBOTOMI IN TUBES.					REMARKS.
	Name.	Percentage strength of.	Amount used in c.cs.	Before starting Experiment.	Alive after 30 minutes.	Alive after 1 hour.	Alive after 2½ hours.	Alive after 9 hours.	
1	Cresol	100	1	2 males 2 females	All	All	All	All	
2	Formalin	40	1	2 males 2 females	All affected	1 male 2 females	Nil	—	All died in 2½ hours
3	Turpentine	100	1	2 males 2 females	2 females	2 females	Nil	—	All died in 1½ hours
4	Turpentine	100	1	1 male 2 females	All affected	Nil	—	—	

Throughout these experiments it was noted that males were more readily killed than females.

From a consideration of the above experiments it was apparent that, of the commoner insecticides used as fumigants, formalin was the one which would prove the most efficient.

Mention should be made of certain experiments, on the same lines as those just considered, using the plant known as pennyroyal. This plant, which grows abundantly in certain parts of the island, locally has a reputation as a repellant of phlebotomi. When the truth of this observation was being put to the test, it was found that the plant had a definite insecticidal action on the *Phlebotomus*. This was shown to occur both with the dried plant and with an infusion made from it (*vide* section on Repellants, page 307). From these facts it was hoped that a cheap, easily worked, and efficient insecticide might be produced. An experiment was accordingly tried on a large scale in one of the huts. The dried plant was placed in a bucket, some methylated spirit poured over it, and, after all doors and ventilators had been closed, a lighted match was thrown on it. Although it burned for some little while, the amount of aromatic vapour given off from a considerable quantity of the plant was small. There was little difference in the total number of the flies in the hut before and after the experiment.

II. PREVENTION OF BITING.

A. REMOVAL OF HIDING PLACES IN SLEEPING QUARTERS.

After dawn, the phlebotomi which remained in the huts usually collected into one of the following places:—

- (1) The four corners, especially at the roof level.
- (2) The men's kits on shelves above the beds.
- (3) Any cobwebs formed in the angle between roof and wall.
- (4) Behind any big lockers.
- (5) The angle between ceiling and supporting iron girders.

The above list has been arranged in the order in which most flies were usually to be found—by far the larger proportion occurring in situations (1) and (2).

On several occasions counts of whole huts were made, to determine the proportion of phlebotomi which occurred at the corners compared with the sides. During these counts the kits on the shelves were vigorously disturbed, and in nearly every case were each found to be harbouring two or three phlebotomi. These observations showed that roughly 50 per cent. of the flies congregated in the corners of the hut when the kits were left on the shelves (Table VIII).

TABLE VIII.

No. of Experiment.	Date.	Hut.	PHLEBOTOMI.				
			Total No. in Hut.	No. at four corners.	No. at sides.	Percentage at four corners.	Percentage at sides.
1	4/6/22	C2	143	71	72	50	50
2	4/6/22	B2	51	32	19	62	38
3	5/6/22	B4	11	5	6	45	55
4	5/6/22	D4	6	3	3	50	50
5	16/7/22	A4	138	64	73	46	54
6	14/8/22	C2	198	76	122	38	62
7	14/8/22	C2	157	74	83	47	53
Average of Seven Experiments.			100	46	54	46	54

To test the effect of removing the kit, permission was obtained to have the shelves in Hut A4 cleared, the extra kit of each man being packed into a second kit-bag. The result of this measure was that most (83 per cent.) of the phlebotomi in the hut congregated in the corners. (Table IX).

TABLE IX.

No. of Experiment.	Date.	PHLEBOTOMI.					Remarks.
		Total No. in Hut.	No. at four corners.	No. at sides.	Percentage at four corners.	Percentage at sides.	
1	30/7/22	60	51	9	85	15	19 out of 27 in one cobweb
2	31/7/22	147	121	26	83	17	
3	1/8/22	138	104	33	76	24	
4	2/8/22	158	126	32	80	20	
5	3/8/22	137	110	27	80	20	
6	5/8/22	170	153	17	90	10	
7	10/8/22	158	131	27	83	17	
8	12/8/22	103	91	12	88	12	
Average of Eight Experiments.		134	111	23	83	17	

Cobwebs acted in a similar manner to the kits, affording both a hiding-place and a certain amount of protection to the phlebotomi from air currents, natural or artificial. Phlebotomi did not become entangled in these webs and were able to move out of them at will, nor did the spiders seem to notice, or resent, their presence.

Frequently, examples were seen of the shelter given to these flies by cobwebs. Thus, on the 27th July, 1922, whilst carrying out experiments with

electric fans, the artificial air-currents created drove the phlebotomi out of the hut, first of all by reducing their numbers in the corners of the hut; in fact, all the corners were soon freed from flies, excepting one which had a large cobweb. This cobweb was gently broken down in order to disturb the flies as little as possible. The phlebotomi remained for some little time in the vicinity of the web, showing that it was not the act of breaking that frightened them away, but now exposed to the full action of the air-currents they departed. (Chart 5).

It was, therefore, evident that cobwebs could and did act as a shelter for phlebotomi, and their removal was followed by an immediate decrease in the numbers of flies in the area concerned.

At any time during the day it was possible to dislodge a varying number of flies from behind the big lockers which were placed in some of the huts, and in the evening the flies were often observed hopping up the wall from behind these lockers and taking refuge in the corners at the roof level. It was nearly always in those corners in which there were lockers that the largest number of flies were counted. (Table X).

TABLE X.

OBSERVATIONS TAKEN FROM HUT A4 FOR A PERIOD OF A WEEK.

Table showing how phlebotomi congregate in corners of huts, especially in those corners occupied by large lockers.

Date.	NO. OF PHLEBOTOMI.		PERCENTAGE OF PHLEBOTOMI.	
	In corners with lockers.	In corners without lockers.	In corners with lockers.	In corners without lockers.
30/7/22	27	9	75.0	25.0
31/7/22	78	33	70.0	30.0
1/8/22	41	30	57.8	42.2
2/8/22	51	42	54.9	45.1
3/8/22	63	36	63.7	36.3
4/8/22	81	31	72.4	27.6
5/8/22	45	28	60.7	39.3
Average of Seven readings.	55	30	64.9	35.1

B. NETS.

The use of nets had usually been discountenanced, on the grounds that material of sufficiently fine mesh to exclude phlebotomi was too oppressive to sleep under in hot weather. In spite of this, experiments were undertaken to ascertain the best type of cotton netting to protect man from the bites of phlebotomi. In order to test the size of cotton mesh through which phlebotomi could work their way, test-tubes and glass jars (6in. diameter) were loaded with known numbers of the flies and covered with nettings of various meshes, with the results shown in Table XI.

TABLE XI.

No. of Experiment.	No. of Mesh to the square inch.*	Thickness of Thread.		No. of Phlebotomi (females).	
		Warp way.	Bobbin way.	At Beginning of Experiment.	Retained by Netting after 24 hours.
1	33/34	103/2	55/S	12	0
2	34/35	120/2	62/S	12	0
3	36	125/2	75/S	12	0
4	36/37	120/2	62/S	12	0
5	39/40	120/2	76/S	12	0
6	40/41	143/2	80/S	12	0
7	41/42	165/2	84/S	12	1
8	42/43	148/2	92/S	12	4
9	43	147/2	80/S	12	3
10	44	165/2	93/S	12	10
11	47/48	146/2	81/S	12	12
12	53/54	146/2	83/S	12	12
13	54/55	180/S	180/S	12	12
14	63/64	180/S	180/S	12	12

* Measurements were taken in two directions; horizontally along the warp and obliquely down the way of the bobbins. The corner hole was counted twice. This is the method adopted in the net trade.

The species of *Phlebotomus* used in these experiments was the *papatasi*. It had been observed, previously, that the males of this species escaped through cotton netting more readily than females, and, as it has been shown that males never bite man, all the experiments recorded above were carried out with female phlebotomi. From a consideration of these experiments it was concluded that cotton net of 45 meshes to the square inch was sufficiently fine to prevent *Phlebotomus papatasi* from biting man. It should be remembered that in these experiments the flies were struggling to escape from imprisonment, and that the efforts they made to penetrate the netting would be greater than those they would make to enter a net for the purpose of feeding on man. Probably in the latter case the fly would seek an easier prey. Furthermore, a *Phlebotomus* swollen by a recent feed of blood could not escape through a net of even 40 meshes to the square inch.

The authors slept, throughout the phlebotonus season, under cotton netting of 54/55 meshes per square inch. The nets were carefully tucked in before sunset and examined daily for phlebotomi. There was no evidence of bites, nor could any phlebotomi be found in the nets at any time.

There was no doubt that nets, which were properly used and kept in repair, gave more protection than any other preventative. (Photos. 15 and 16.)

C. REPELLANTS.

Numerous aromatic substances have been recommended for the purpose of smearing on the exposed parts of the body to repel phlebotomi and, incidentally, various other biting insects.

Before any experiments were done, a striking example of the value of repellants was observed. An aircraftsman, who had volunteered to be bitten

by phlebotomi, came to the laboratory after his work. This had consisted of cleaning an engine with paraffin. His arm was introduced into a cage containing some 200 phlebotomi. Before the arm was put in, the walls and roof of the cage were covered with the flies; immediately after there was not a fly to be seen. All had disappeared as if by magic into the loose stones and earth on the floor of the cage. So long as the limb remained in the cage, no flies could be seen. After an interval of ten minutes, the arm, which had been thoroughly washed in the meantime, was reintroduced, and the flies fed from it readily. Experiments carried out on similar lines, with other volunteers, gave corresponding results; in one instance this repulsion was observed three hours after the smearing on of paraffin. Many of the phlebotomi appeared to be stupefied by the fumes.

The substances tested as repellants were:—

1. Paraffin.
2. Camphor.
3. Thymol.
4. Linseed oil.
5. Peppermint oil.
6. Pennyroyal.

The experiments were performed in test-tubes which were broken at the bottom end. The substance to be tested was placed on, in the case of solids, or if a fluid soaked up by, a cotton-wool plug, and thus introduced into one end of the test-tube. Several phlebotomi were introduced by the open end of the tube, which was then plugged with cotton-wool. Thereafter, the tube was placed vertically, first of all with the test substance in the lower part of the tube, and later reversed, so that the test substance was in the uppermost part. The movements of the flies were noted at different times. Male phlebotomi always settle in the highest part of the tube, whereas it is only the non-pregnant or not recently fed females which do so. With nearly all the substances which were tried the flies remained as far away from the test substance as they could, in whatever position the tube was placed. At times, however, the movements of the flies were very erratic, and, in consequence, the results were often difficult to interpret (Fig. 2).

Pennyroyal has, locally, a considerable reputation as a repellant. The Maltese bind bunches of the plant to the head of their beds to keep phlebotomi from biting. Several of the aircraftsmen tried this method, but all were certain that they were bitten, despite the plant.

That pennyroyal has a definite action on the fly was shown by the following experiment. A little of the crushed plant was put in the bottom of a test-tube and one female phlebotomus was introduced. The fly was shaken to the bottom of the tube, where it remained entirely stupefied. After four minutes it was lying on its side, making a few convulsive movements. It was then shaken to the top of the tube and the plug removed. Three minutes later, during one of the convulsive movements, it jerked itself out of the tube. It now lay on the bench, and after four minutes it stood up, but could not fly. Complete recovery occurred after another fifteen minutes. In other experiments of a similar nature, but using an infusion of pennyroyal, several of the flies were killed.

It was extremely difficult to judge the value of the various substances tried, but the opinion was formed that paraffin and camphor were the most efficacious.

TABLE XII.
TABLE SHOWING THE PERCENTAGE OF CASES OF PHLEBOTOMUS FEVER OCCURRING IN UPSTAIRS AND GROUND-FLOOR HUTS.
(Incidence of the fever in the total personnel).

GROUND-FLOOR HUTS.				UPSTAIRS HUTS.			
No. of Hut.	No. of Cases of Phlebotomus Fever.	No. of Men in Hut.	Percentage of Men infected with Phlebotomus Fever.	No. of Cases of Phlebotomus Fever which relapsed.	No. of Hut.	No. of Cases of Phlebotomus Fever.	No. of Cases of Phlebotomus Fever which relapsed.
A4	8	18	44.4	1	A3	3	0
B2	3	18	16.6	1	B1	3	0
B4	12	19	63.1	5	B3	0	0
TOTAL	23	55	41.8	7	TOTAL	6	0

Note the higher percentage of fever cases which occurred in the ground-floor huts.

TABLE XIII.
TABLE SHOWING THE PERCENTAGE OF CASES OF PHLEBOTOMUS FEVER OCCURRING IN UPSTAIRS AND GROUND-FLOOR HUTS.
(Incidence of the fever in newcomers).

GROUND-FLOOR HUTS.				UPSTAIRS HUTS.			
No. of Hut.	No. of Cases.	No. of New-comers.	Percentage of New-comers infected.	Relapse.	No. of Hut.	No. of Cases.	Percentage of New-comers infected.
A4	6	8	75.0	1	A3	3	50.0
B2	3	7	42.8	1	B1	3	21.4
B4	12	12	100.0	5	B3	0	0
TOTAL	21	27	77.7	7	TOTAL	6	21.4

Note the higher percentage of fever cases which occurred in the ground-floor huts.

D. AIR CURRENTS.

(i) *The Effects of Natural Air-Currents.*—The effect of natural wind currents on the occurrence of phlebotomi has been noted by many workers. As isolated observations are valueless, a definite system of observation was established at Calafra, Malta, in May, 1922, and continued for six months from that date, that is, throughout the phlebotomus season. The results showed a definite relationship between the force of the wind and the number of flies found indoors; roughly speaking, the flies were present in inverse proportion to the force of the wind. A force-four (Beaufort scale) wind, blowing for two or three consecutive days, cleared the phlebotomi from the huts, on the windward side of the camp, while in those to the leeward there was a considerable reduction. This reduction was most evident in the upper storeys of the buildings, due, in part, to the lesser number of phlebotomi which gained access to the higher floors at all times, and, in part, to the more free circulation of wind currents. The relatively small number of phlebotomi found at any time in the upper storeys was proved by counting daily the actual number of flies in each hut, and confirmed by the few cases of phlebotomus fever which occurred amongst the men sleeping in such places (Charts 6 and 7, Tables XII and XIII). The flies bred and hatched out at the ground level, and, therefore, had to mount to the higher, better ventilated levels to invade them. Such delicate, light flies preferred the calmer air of the lower floors.

A good illustration of the effect of air-currents on phlebotomi was obtained in the huts allotted to the Maltese airmen. On alternate week-ends the port and starboard watches got 36 hours' leave. Their huts, as a precaution against theft, had the doors and windows closed. This lack of ventilation caused a bottling up of the human odours emanating from various articles of clothing and bedding left in the hut. These odours attracted the phlebotomi, which entered by means of wall-ventilators and chinks created by ill-fitting windows and doors. The flies were watched collecting here over a period of 36 hours, and, when the windows at one end of the hut were opened, most of them gradually moved to the sheltered end of the building. This process was repeatedly observed in these huts. Moreover, in any hut, the majority of the flies was always found in the most secluded corners, depending on the direction of the wind.

These observations suggested that the spacing out of buildings to gain the full advantage of natural air currents would reduce the phlebotomus and fever incidence considerably. It was not practicable to suggest removal of any of the recently erected permanent buildings; as an alternative, the creation of artificial air-currents by means of electric fans was tried. The results were most encouraging.

Here was, at least, a partial solution to the problem. Free ventilation, to make the most of the natural movements of the air, supplemented by artificial air-currents in the lower part of the room to repel the invaders and render the act of biting man a difficult one, and in the upper part to deprive them of their resting and pairing haunts. In order to obtain some practical information regarding the value of artificial air-currents, and the minimum

expenditure necessary for a satisfactory result, certain electric fans were provided; two large overhead fans to act chiefly on the lower parts, and four small oscillating desk fans for the upper parts of the room.

(ii) *The Production of Artificial Air Currents by means of Electric Fans.*—It was not until the 26th July, 1922, that the electric fan experiments were started. Every inhabited hut in the camp had at that date been under a detailed observation for sixty-six consecutive days. By this time sufficient data had been collected to account for various minor fluctuations in the invasion of the huts by the phlebotomi. The chief error that was likely to occur was a reduction in the number of flies through a strong wind blowing. Fortunately, throughout the period of these experiments (26th July, 1922, to 10th August, 1922), there was either a dead calm, or, at most, a wind-force of 1, except on the last day of the first set of small fan experiments, when for part of that day the wind-force was 4. However, the experiment was repeated at a later date (Chart 9, Column C), and calm weather prevailed throughout. The result of these two series of experiments coincided.

Other factors which were liable to affect the fly incidence were the atmospheric, earth and water temperatures, and the atmospheric humidity; these were fairly constant, and corresponded closely with those prevailing during the three previous weeks. The mean daily temperature varied from 76° F. to 83° F. This range had been shown by various observers to be favourable for the development of the phlebotomus, and was confirmed by experiments at Calafra. Throughout the experiments the earth (4ft. tube) and water temperatures were 74° F. and 76° F. respectively. The humidity varied daily from 60 to 90 per cent.

Hut A4 was chosen for the fan experiments, as it was definitely the most heavily infested hut in the camp, and was situated nearer to the natural breeding-grounds of the phlebotomus than any of the others.

The particulars regarding the fans used for the experiments in the hut were:—

SMALL FANS.						LARGE FANS.	
Type of fan	...	Oscillating desk-fan swinging through angle of 90°	...	...	...	Punkah ceiling fan	...
Number of blades	...	Four...	...	...	...	Three	...
Overall diameter of blades ...	...	Eighteen inches	...	...	...	Fifty-four inches	...
Revolutions at top speed ...	...	1,000 per minute	...	...	...	220 per minute	...
Position of fans in room ...	...	Supported on wooden brackets three feet from ceiling. One in each corner of the room	...	...	...	Hung from roof three feet from ceiling and eight feet from floor. The two fans divided the length of ceiling into thirds	...
Number of fans used ...	Four ...	...	...	...	...	Two	...
Plane of rotation of fans ...	Vertical	...	...	...	...	Horizontal	...

(iii) *Estimation of Air Currents produced by the Fans.*—The air currents produced by the small and large fans were tested separately. To eliminate natural air currents the doors and windows were closed, and, after an interval of fifteen minutes, to allow the air to settle, the fans were set in motion at top speed. A piece of cotton-thread with a small piece of cotton-wool at its free end was suspended in the air at various parts of the hut to act as an anemo-

meter. The air currents were recorded for each area by noting the angle to which the cotton-thread was deviated from the perpendicular; the angle of deviation in degrees gave the comparative force figure; for example, an angle of 45° gave a comparative force figure of 45. One series of readings was taken one foot below the ceiling level (where most phlebotomi congregated) and another three feet above the floor level, at the head end of each bed (plane at which most of the bites occurred). Chart 8 was drawn up from the results thus obtained.

It was found, in the case of the small fans, that the air-currents produced one foot below the ceiling level were strong up to 10 feet from each corner, giving a comparative force figure (C.F.F.) of 80, and moderately strong between 10 and 20 feet from each corner (C.F.F. 45); while at the central portion of the long walls of the hut, 30 feet from either end, the air-current was relatively small (C.F.F. 15). At the bed level (3 feet off the ground) and at the head end of the bed the air-currents were much weaker; the readings at 10, 20 and 30 feet from each end of the hut giving a C.F.F. of 15, 10 and 5 respectively, or roughly one quarter of those at the corresponding positions in the upper part of the room.

As regards the large ceiling fans, one fan with aluminium blades worked much more efficiently than the one with wooden blades. However, the general results coincided in both cases, the difference being purely one of degree. The figures given by the more effective of the two large fans were accepted as correct, as the other fan had a mechanical defect due to damage received in transit to Malta. Their effectiveness at ceiling level was almost nil, being greatest (C.F.F. 15) on the portion of the walls opposite the point of their insertion into the roof. At the bed level they were considerably more effective, giving a C.F.F. of 45 at the head end of the beds, opposite their insertion into the ceiling, a figure of 30 ten feet further down the room in either direction, and 20 at the ends of the room.

In short, the small corner fans acted efficiently in the upper part of the room, but less so in the middle and lower regions, whereas the large ceiling fans were effective where the smaller ones failed relatively. The correctness of these observations was borne out by the results of the experiments with these fans on the movements and dispersal of phlebotomi from the same hut (Chart 9).

E. ESTIMATION OF THE NUMBER OF PHLEBOTOMI IN THE HUT.

Practically all the phlebotomi in the hut gathered on the walls or their fixtures and hangings. In order to simplify the counting, the walls were divided into areas, the delimiting mark of these areas being the centre of each window; in this way there were five areas on each long wall, a central area over the doorway in each short wall, and four corner areas.

In order to minimise error as much as possible, throughout the experiments all counting in the hut was done by one observer, at definite hours, and exactly the same routine was observed at each count. The routine adopted was to count the phlebotomi in each of the areas mentioned above, commencing at the foot of the wall, and then by means of a ladder counting

those at the higher levels. The ladder was used in each area, and was found to be absolutely necessary in order to get near enough to distinguish the phlebotomi from other insects and also to determine the sex. So long as no undue movements of air were created, the flies did not seem to mind how near the observer was to them, but they were readily disturbed by such actions as the slamming of a door, although they rarely moved far from their original position.

Any kits on shelves or hanging on hooks were shaken, and a short time allowed for any phlebotomi which had flown or hopped out to settle down. As it was found that large numbers of the flies sheltered in the kits which were folded up on a shelf above the beds, and also in any clothes and equipment which were hanging up, arrangements were made to have all the kits removed. This lightened the task of counting the flies, as they were much more easily picked up on the blank wall. Some difficulty arose when large numbers occurred in one corner, as was often the case, owing to movements among the flies. Unless disturbed, however, the majority kept quite still, and it was only when twenty or more were clustered together that any error was likely to arise, and even when the number greatly exceeded this the error must have been very small.

The flies were, undoubtedly, more difficult to count as the evening wore on, owing to increased liveliness, while during the day they were often distinctly sluggish.

F. ACTUAL FAN EXPERIMENTS.

(a) *Small Fans i (Chart 9, Column A)*.—This series of experiments was commenced with the smaller fans, which were started, at top speed, on the 26th July, at 10.30 a.m. The total number of phlebotomi was counted just before the experiment, and 138 flies, consisting of 76 females and 62 males, were found in the hut. There were rather more flies on the side walls than at the corners.

The fans were kept running continuously for eighty-two hours.

The result was a fairly constant diminution of the total number of flies in the hut. This diminution was seen first to affect chiefly the flies in the four corners of the hut, the number being reduced to less than half after the fans had been running one hour (Chart 9, Column A). No further reduction was shown at the ends in the next two readings, at five and nine hours after the commencement. There was, however, a gradual decrease in the numbers at the sides, due, largely, to the fact that the flies were driven out of their hiding-places in the kits during the first count and so exposed to the action of the fans.

At the ends of the hut, the constant count resulted, mainly, from the fact that flies which had gathered in the corners behind the fan were safe so long as they remained there. In these corners they were held prisoners, and many gradually died, as proved by the finding of their dead bodies on the wooden brackets supporting the fans. In another area, outside the actual corner, a cobweb gave shelter to several phlebotomi; when the web was gently broken down the homeless flies were soon dispersed.

About midday on the 28th July all the kits and equipment were removed from the shelves and hangers, and were stowed away in kit-bags. After this procedure the number of phlebotomi found on the side walls was always small, except in a few cases where a cobweb had formed and the flies had taken refuge therein.

The dry and wet bulb readings in the hut, just prior to commencing, were 81° F. and 69·5° F. respectively; the wind was south-west and about force 1. The fans showed little or no effect on the humidity of the atmosphere in the hut.

After eighty-two hours' continuous running the hut was very thoroughly searched but only five flies could be found.

(b) *Reaccumulation of Flies (Chart 9, Column B).*—An analysis of Chart 9, Column B, demonstrated two points regarding the reaccumulation of flies. Firstly, it showed the decrease which occurred during daylight, as a result of some of the fed flies leaving the hut to go to the breeding-places. Secondly, it showed the value of removing all the kit, etc., from the walls. When the kit was on the shelves or hung up, roughly 50 per cent. of the total flies in the hut were on the side walls; after the removal of the kit the percentage rarely rose above 25.

(c) *Large Fans (Chart 9, Column C).*—The large fans were started at 10.30 a.m. on the 3rd August, and were run continuously for forty-eight hours. During this period they failed to produce any reduction in the total number of phlebotomi, in fact, the number gradually increased, especially at the ends. Despite this fact, the men sleeping in the hut were definitely of the opinion that they were less worried by the flies while these fans were working than when the smaller ones were in action.

(d) *Small Fans ii (Chart 9, Column D).*—The small fans were started again at 10.30 a.m. on the 5th August, and the reduction in the number of flies which occurred coincided very closely with that obtained in the first experiment. After seventy-two hours' continuous running the number of the flies had been reduced from 170 to 18.

As previously stated, the meteorological conditions were very constant during this experiment; in particular, the wind-force was rarely above force 1.

From a consideration of the above experiments and of the effect of natural winds on phlebotomi, it was evident that, if properly used, electric fans afforded an excellent means of protection from the bites of these flies.

SUMMARY OF PROPHYLACTIC EXPERIMENTS.

I. WAR ON THE INSECT IN ITS VARIOUS STAGES.

A. ABOLITION OF THE BREEDING-GROUNDS.

The levelling of and rendering impervious the surface of the ground, and the facing and pointing of walls and buildings, materially reduced the number of phlebotomi in the camp. These measures were only carried out for

a distance of 15 yards beyond the huts ; had this distance been extended to 50 yards the reduction in number of the flies would have been greater. That this further reduction would have occurred was evident from the following incident. In one part of the camp flies collected despite these prophylactic measures, and a survey of the ground around showed a phlebotomus haunt about 20 yards from the huts. This was treated, and the fly incidence dropped immediately.

B. DESTRUCTION OF THE ADULT FLY.

(1) Swatting of the phlebotomi which gathered in the corners of each hut was a very satisfactory method of killing large numbers of these flies. Even when the kits were allowed to remain on the shelves, 50 per cent. of the total number of flies in a hut collected in the corners, and were easily killed.

(2) Spraying by means of such an instrument as a Meyer's knapsack sprayer was a very efficient means of dealing with these flies. A 1 per cent. solution of cresol acted best. This prophylactic measure had the advantage of acting against other pests, such as fleas, house-flies, and even bed-bugs.

(3) Fumigation on a large scale had little effect on the phlebotomus.

II. PREVENTION OF BITING.

(a) Removal of hiding-places in sleeping quarters.

Kits, cobwebs, and large articles of furniture that could not be easily kept clean, gave protection to phlebotomi. Their removal reduced the number of phlebotomi in the huts, and made the other prophylactic measures more easy to carry out.

(b) Cotton-net, of at least 45 meshes to the square inch, had to be used to attain proper protection.

(c) Repellants aided to a certain extent. Paraffin and camphor were the best.

(d) Air-currents had a marked effect on phlebotomi, as was shown by the great decrease in the number of flies whenever a strong wind was blowing, and also by the few flies found in the upper storeys of buildings. As regards electric fans, the small fans produced the strongest currents, and, apparently, gave the best results. This type of fan acted chiefly in the upper part of the hut, and prevented the flies from settling there after they had had a blood-feed on the men below. There was no evidence to show that the flies did not enter the hut, bite man, and depart as they had come. In fact, several of the men affirmed that they were bitten despite these small fans. Had the small fans been mounted three or four feet above the floor level, it would have been difficult, if not impossible, for the flies to bite the occupants of the hut. However, the small fan experiment proved definitely that such fans could prevent phlebotomi from collecting in a room, provided the walls were kept clear of hangings. On the other hand, the large fans prevented the flies, to a certain extent, from biting the men, but failed to stop them entering, leaving or collecting in the hut.

RECOMMENDATIONS FOR A CAMPAIGN AGAINST THE PHLEBOTOMUS.

From a survey of the foregoing experiments it is possible to make recommendations for a campaign against the *Phlebotomus*. No one measure can be expected to produce complete eradication—each is dependent, to a certain extent, on some other, and, to attain success, as many measures as possible should be brought into use. It cannot be too strongly emphasised that the campaign is an even more arduous one than that which is being waged against the mosquito; the breeding-places of phlebotomi are as numerous and more difficult to treat, while the smaller size of the insect adds greatly to the difficulty. Half-hearted measures will inevitably end in failure.

Further, there is evidence that other pests, such as lice, bed-bugs, or mosquitoes may, in some circumstances, act as vectors of phlebotomus fever. Hence, in conjunction with the campaign against the *Phlebotomus*, measures must be taken to deal with these other creeping and winged pests.

The degree of success will depend largely on the situation and local conditions of the place in question. It is realised that the Air Force Station at Calafra is an ideal spot for a campaign against the *Phlebotomus*, owing to its comparatively isolated position, and to the fact that it is bounded by the sea on three sides. In other places certain of the measures recommended will be impracticable or useless, but some of the measures, such as the use of electric fans or punkahs, swatting and spraying, will be of great value anywhere. Further researches by medical officers in the areas concerned, on lines similar to those detailed above, are necessary to attain the maximum of success.

(1) WAR ON THE INSECT IN ITS VARIOUS STAGES.

A. ABOLITION OF BREEDING-GROUNDS.

Certain facts have emerged from the study of the life-history of the *Phlebotomus* regarding the conditions necessary for its successful breeding. Briefly, the requirements are :—

- (1) Organic matter.
- (2) A certain amount of moisture.
- (3) A definite range of temperature.

Of these factors the first can be influenced most, the second is more difficult to deal with, while it is impossible to control the third.

The object to be aimed at is to eradicate all breeding-places over as large an area, in and around the camp, as is practicable. Every inch of the ground in this area must be treated.

TREATMENT OF THE GROUND IN THE CAMP AREA.

(a) *Broken Ground*.—The ground surface should first of all be levelled : no areas of waste land should be permitted to remain within thirty yards of any dwelling. The surface should, wherever possible, be made up with small stones or road metal, which should be rolled in with a heavy roller. Places inaccessible to the roller, especially the junction of buildings and walls with the ground surface, should be thoroughly rammed in by hand. In those

places where the surface is of sand, some other method of consolidation must be used, which will depend on the local conditions.

After the surface has been made level, some dressing must be applied to render it impervious and prevent crumbling. This dressing will vary with the character of the soil, the cost in the locality, and the means of application. The commoner dressings are concrete, tar, or some crude oil.

Concrete is, undoubtedly, the best dressing so far as the eradication of phlebotomi is concerned. There are, undoubtedly, certain disadvantages in connection with the use of this material. The initial cost is great, but, considering that repairs are necessary only at long intervals, there is ultimate economy. It tends to reflect heat, and the glare from its surface is injurious to the eye. This element of glare could be partly remedied by the use of green or black concrete. Despite these drawbacks, concrete is, undoubtedly, the best surface dressing for a station such as Calafra.

Tar makes an excellent dressing, and would probably be more suitable for sandy soils. It is also cheaper than cement, but it does not last so long, and the surface would require to be resprayed at yearly intervals. The cost of tarring at Calafra worked out approximately at 1½d. per square yard, this being the total inclusive cost. The objection has been raised that during the hot weather the surface would become sticky; at Calafra, during the hottest weather experienced, this was not found to be the case; the tar sinks into and binds together the porous soil. Like cement it reflects the heat, but the black colour is more restful to the eye.

Crude oil and waste engine-oil could be used in temporary stations. In such a station as Calafra there are ten gallons of waste engine-oil each week. This could be sprayed over the ground from watering-cans, and, if properly done, would be quite effective. It would, however, have to be done frequently, and is not suitable for a permanent camp, except as a dressing to apply to waste areas beyond the zone of active treatment. This spraying tends to kill off larvæ and pupæ, and should be done weekly.

Apart from lessening the incidence of the *Phlebotomus*, the above measures will help to keep down dust and dust-borne diseases.

(b) *Prevention of Breeding in Walls and Embankments.*—Loose stone walls should be demolished in the camp area, and in the case of boundary walls these should be replaced by iron or wire fencing, or by a properly constructed stone wall.

Old stone walls which cannot be removed should be repaired and pointed, and tarred in their lower three feet.

Loose banks should be faced with stones, pointed and tarred. If the embankments are of such a size that the foregoing recommendation is impossible, they should be built up with stones and the interstices filled with earth, rammed tightly home. In an endeavour to prevent phlebotomi from breeding in such a bank, pennyroyal or thyme, both of which act as repellants to these insects, should be thickly planted thereon, or the surface should be sprayed weekly with waste engine-oil.

(c) *Construction and Maintenance of Buildings.*—Walls of buildings should be properly faced and all cracks filled up with cement. To preserve

the stone the lower three feet of the wall should be tarred. The money spent in procuring the better quality Maltese stone, and by using a good cement, amply repays itself, both as regards the life of the building and the health of the personnel. This statement is borne out by a critical examination of the present conditions of two types of buildings, situated practically side by side, at Calafra. The one, erected eighteen years ago, presents an unbroken surface, the cement being as good as new; the other, built during the last two years, has already begun to crack badly, the cement dropping away in large pieces, and the face of the stones flaking off, leaving innumerable hiding-places for insects.

The frames of windows and doors should fit accurately, and any crevices produced by such conditions as warping of the frames should be immediately repaired. Private individuals may attain a considerable degree of protection by covering the open windows with butter muslin of 45 or more meshes to the square inch; this material should be carefully tacked to the window frame.

All ventilators of buildings should be accessible and of large size; their corners should be as few as possible, and rounded off to prevent accumulation of dust and dirt. They should be cleaned daily, and have their sides frequently rubbed with a rag moistened with paraffin. The frames and fly-proof netting of ventilators must be kept in good repair.

Openings in walls for the ingress or egress of pipes should have careful attention. Should a certain amount of space be required to allow for expansion of the pipe, the orifice left should be guarded with finely meshed netting. It would be an advantage to conduct pipes through a ventilator so as to have room to clean the space left around them.

Where possible the roofs of buildings should be of stone. Wooden roofs gradually gather moisture, partly by leakage of water through the canvas or other material used to cover them, and partly by absorption of the condensation moisture which gathers on their inner surface. The amount of moisture absorbed in sirocco weather is considerable. Dust lodges in the interspaces between the planks forming the roof, and, with the moisture, provides the necessary conditions for the breeding of the phlebotomi and other insects. These insects gradually find a home in the stonework, especially in crevices between the stones forming the walls. Gales, which are of frequent occurrence in Malta, exert considerable pressure on these wooden roofs and their supporting joists; the cement binding together the stones in the vicinity of these joists breaks away, and, by a vicious circle, the building deteriorates. The use of temporary wooden roofs is much to be deprecated.

Knowing the amount of moisture necessary for the development of the *Phlebotomus* in its various stages, proper provision should be made for the disposal of all waste water, rain and dew. Eaves-gutters should be fitted where required, to prevent water dripping to the ground adjoining the house walls. Further, as numerous phlebotomi are found to breed in the ground in the immediate vicinity of buildings, it is necessary to carry a cement channel all around the foot of each building to collect condensation and other waters. These channels should be properly aligned, kept clear, and discharge into

a well-constructed drain. The habit of throwing waste water on the ground to percolate away should be strictly forbidden (Photograph 12).

All woodwork, walls and ceilings of buildings should be painted, distempered, tarred or whitewashed, yearly, preferably at the end of the rainy season (April to May in Malta). These measures preserve the surfaces treated and tend to kill off any eggs or other forms of insect life infecting them.

It cannot be too strongly emphasised that, in tropical and sub-tropical climates, gardens in the immediate vicinity of buildings should not be permitted from a sanitary point of view. The daily watering of the manured soil provides the moisture necessary for the breeding of the *Phlebotomus*, while the foliage gives shelter to innumerable pests. Creepers on the walls of buildings should be strongly condemned; they are injurious to the soft limestone forming the walls, and aid midges and mosquitoes to reach the upper storeys (Photographs 13 and 14).

The keeping of fowls or similar animals within the area of the camp should not be permitted. Fowl runs, formed of soft ground containing much organic material and repeatedly moistened, are ideal breeding-places for phlebotomi, especially as these insects feed on the blood of fowls and other birds. As such animals are known to suffer from spirochætal diseases they may possibly act as a reservoir for infection.

Until more is known of the limits of flight of the *Phlebotomus* the area of the camp treated should be as extensive as possible. To this end every attempt should be made to have parade grounds, playing fields, etc., adjoining the men's quarters, for by this means a large area of ground around the camp could be rendered unsuitable for the breeding of the *Phlebotomus*. Moreover, air currents would have full play upon the camp.

Building operations and other works which disturb the surface of the ground should, if possible, be done in the cold weather, otherwise crannies are created in which all manner of insects will breed. Any breakage of the surface, which does occur in the summer, should be sprinkled with crude oil and speedily closed up. The practice of commencing digging and building operations, and then leaving the work for months before completion is to be condemned.

B. DESTRUCTION OF THE ADULT FLY.

It has been shown that a war on the adult fly has every hope of success if carried out methodically and diligently.

(i) Swatting, though a somewhat laborious but inexpensive method, is of undoubted value as a part of the campaign. By breaking the camp up into small areas, each with a swatting party, the amount of individual labour will be considerably reduced. The method employed should be that outlined in the foregoing pages. The swatting should be done daily during the hour prior to sunset. The medical officer in charge can easily keep a check on this work by means of surprise visits—any neglected corners are detected immediately.

(ii) Spraying should be carried out at least twice weekly, by the party detailed to do the swatting; a 1 per cent. solution of cresol is the best fluid for this purpose, and should be applied by either the Meyer's knapsack or the

Mackenzie's fly-spray. The spraying should be started in the corners of each room, first at the ground level and then working up the wall to the ceiling. Ventilators and all spaces behind the larger articles of furniture should be well treated, for many phlebotomi shelter in such situations. Daily treatment is to be recommended, if the cost can be defrayed, and in this case swatting could be dispensed with. In this connection it is necessary to bear in mind the lethal action that cresol spraying has on flies, fleas, and insects in general.

II. PREVENTION OF BITING.

(a) The removal of the hiding-places of phlebotomi in sleeping quarters renders the disinfection of any hut easier, for these insects, deprived of other places of shelter, gather in the corners of the room, where they can be swatted or sprayed readily.

The chief hiding-places are in the kits, and behind cobwebs and large articles of furniture. In hot, moist and dusty climates it seems absurd to keep spare kit hanging about in the huts. This kit, being chiefly winter clothing, is not worn for five or six consecutive months, and simply serves to harbour dust and moisture; the kit fades in colour and by its impregnation with organic matter, from such sources as the sweat, forms an ideal breeding-site for all manner of insects.

All spare kit should be packed in a properly labelled kit-bag and handed into a kit store until required; should this not be practicable, as in temporary camps, all kits should be shaken and dusted daily.

All huts should be thoroughly cleaned daily, cobwebs removed, ventilators cleared, floor and especially corners and areas behind large articles of furniture washed. To aid the cleaning all large pieces of furniture should be raised about 4 in. to 6 in. off the floor on legs, and an air space left between the article and the wall. The addition of 0.5 to 1 per cent. of cresol, or a little paraffin, to the cleaning water is to be recommended.

(b) Cotton nets of 45 or more meshes to the square inch give a considerable amount of protection against the bites of phlebotomi. The netting may be fastened to the frames of windows to keep these midges from entering the rooms, or erected over and around beds to give protection to the occupant. Unless these nets are kept in good repair and properly tucked in before sunset they will probably do more harm than good (Photographs 15 and 16). All cases of phlebotomus fever should be compelled to sleep either under such nets, or in a phlebotomus-proof room, for although this insect has been shown to inherit or become infected in its breeding-haunts with the virus of the fever, passage from fly to man and *vice versa* is liable to exalt the virulence of the disease.

(c) Repellants, such as paraffin or camphor, could be used as an additional protection against midges. Paraffin smeared over ventilators, bedsteads, and the lower corners of rooms, aids in part by repelling the fly, in part by killing the ova or larvæ of any insects with which it comes in contact; spread lightly over the skin it is of considerable efficacy, but somewhat objectionable owing to its odour and greasy nature. Camphor may be used in bed, either in a sachet placed under the pillow, or worn as an amulet around the neck.

(d) Air currents, natural and artificial, should be fully utilised. If possible, all sleeping quarters should be upstairs; in this manner the maximum effect of natural air currents is obtained. The advisability of this measure is shown by the relatively few phlebotomi and cases of fever occurring in the upstairs huts compared to those occurring on the ground floors (Chart 6 and 7). The ground floor rooms should be used for such purposes as recreation rooms, messes, canteens, wash houses, bath houses and kitchens.

The distance between buildings should be as great as possible, certainly greater than the height of the building; moreover, there should be space for the free circulation of air currents all round each building. The partial or complete blockage of passages between buildings by annexes should not be allowed (Photograph 17).

It is recommended that a combination of the large and small types of electric fans, or electric punkahs, should be used for large barrack rooms. This would entail the use of six fans, 4 small and 2 large, for a floor space of about 1,000 sq. ft.

Electric fans are not a measure directed solely against phlebotomus fever. It should be remembered that the *Phlebotomus* is not injurious only as a transmitter of that fever, but also by its irritating bite it causes considerable loss of sleep, septic spots and, perhaps, oriental sore. Fans greatly aid in lessening these disease conditions, and by repelling mosquitoes decrease the incidence of malaria; in addition, their use in assisting evaporation and so reducing heat effects is well known. Nevertheless, electric fans have certain drawbacks; their noise may interfere with sound sleep and the draught they set up may act injuriously on the chest or abdomen; for these and economical reasons the smaller the number of fans used in any room the better.

Although these considerations lead to the recommendation of the general use of fans or punkahs overseas, it is realised that, however efficiently controlled, they will not absolutely prevent man being bitten; they should be used in conjunction with the various other prophylactic measures detailed above.

It is difficult to draw up a definite scale of equipment of fans for all rooms without knowing the construction and size of each. For instance, rooms on the second storey, with a relatively better natural ventilation and consequently smaller number of flies, will need fewer fans than ground-floor rooms. The easiest solution of the problem is to give figures for rooms of various sizes; the numbers given are those strongly recommended for adoption in Iraq, India, Palestine, Egypt and the Mediterranean.

SCALE OF ELECTRIC FANS RECOMMENDED FOR DWELLING ROOMS IN TROPICAL AND SUB-TROPICAL CLIMATES.

Floor space of room in square feet.	No. of large ceiling fans (54 in. span) required.	No. of small desk fans (18 in. span) required.
1,500	3	2
1,000	2	2
500	1	1
Less than 500	—	1

The position of the fans will have to be modified according to the room and its contents. Direct draught on the body must be avoided.

In the case of a room of a 1,000 to 1,500 sq. ft. floor-space, the large fans should be placed so as to divide the ceiling into three or four equal parts, depending on whether two or three fans are used. The blades of the fan should revolve at a height of ten to twelve feet above the floor level; this height gives the fans a good sweeping radius. The small type of fan should be erected as near as possible to the middle of each of the shorter walls of the room, either on a support three feet from the ceiling or three feet above the floor; this will bring the centre of each fan in one case two feet below the ceiling and in the other four feet above the floor level. Although time did not permit of actual experiments being made with the small fans erected four feet above the floor, a consideration of the air-currents produced by these fans (Charts 8 and 10) shows that, if the fans were used at this level, flies would have great difficulty in entering and moving about in the lower parts of the building. If the flies in the upper parts of the room are efficiently dealt with by other prophylactic measures, and if due precautions are taken to avoid direct draughts, this, undoubtedly, would be the better position for the small fans.

For rooms of 500 sq. ft. floor-space one large ceiling fan should be hung from the centre of the ceiling, about ten feet above the floor. In addition, only one small fan is necessary and should be placed at one corner of the room, in such a way that it will sweep the whole area of the room; this can be easily accomplished by a fan swinging through an angle of 90°. The corner chosen should be one which will allow the fan to play directly on the window or windows during part of its swing; in this way phlebotomi will be hampered in their attempt to enter the room (Chart 10 C).

Smaller rooms than the above, such as bedrooms and sitting-rooms, should be provided with one small desk fan. This can be placed wherever desired. If supported on a table in one corner it can be made to sweep the whole area of the room, as described above. The bed can be placed so as to get sufficient air-current without draught (Chart 10 D).

The wearing of suitable clothing after sunset aids in preventing many bites from phlebotomi. Shorts should not be worn after sundown; when sitting about in slacks it is advisable to fold them in at the ankles and pull the socks up on them. Another method would be the wearing of a short ankle puttie as worn with the Norwegian ski-ing costume. The Wellington type of boot is a great protection during the evening.

Bathing should not be indulged in after sundown. Many people are bitten by phlebotomi whilst lingering about the shore after an evening bathe. There is adequate time during the day to bathe; in fact, bathing is much overdone at many places abroad, and frequently predisposes to abdominal trouble.

It is suggested that the older resident, preferably those who have already had the disease, should sleep in the corner beds, the newcomers occupying the beds towards the centre of the room. This measure is necessary as most of the phlebotomi gather in the corners of rooms. A considerable percentage of the early cases of phlebotomus fever in a camp occurs amongst men sleeping in the corner beds of huts, and newcomers are less immune to the fever than older residents.

SUMMARY OF RECOMMENDATIONS.

To attain the best results concomitant with the minimum expenditure of labour and money, the prophylactic measures detailed above must be carefully planned and supervised. For the purpose of administration these measures come under two headings:—

1. General (to be carried out by the community as a whole).
2. Personal (to be carried out by the individual).

1. General measures are to be preferred as they are more fully under control. All areas should be inspected at the end of the rainy season each year; this is, in the case of Malta, early in May. During the inspection special attention should be paid to the following:—

- (1) The ground surface, as regards levelling, impermeability and drainage.
- (2) Buildings for cracks and holes in the walls; ill-fitting frames of windows, doors or ventilators; eaves-gutters; holes in any fly-proof screens fitted.
- (3) Walls and embankments, as regards necessary facing, pointing or tarring.

All the necessary repairs, tarring, painting and lime-washing must be carried out immediately before the warm weather sets in. Each year the interior of all rooms should be washed down and painted or lime-washed, the lower three feet of the walls of all buildings tarred, and the ground surface sprayed with tar for a distance of twenty feet beyond the living quarters. This last measure would not be required in a place where the ground surface around the building is covered with concrete.

2. The individual should see daily:—

- (1) That the phlebotomi in the corners of their rooms are swatted, or sprayed with a 1 per cent. solution of cresol.
- (2) That all rooms are thoroughly cleansed, especially the corners.
- (3) That all cobwebs are removed.
- (4) That ventilators are kept free from dirt, and are smeared with paraffin.
- (5) That all gulley traps are kept clear.
- (6) That the ground at the junction of walls of buildings is free from organic débris and dust.
- (7) That all refuse is properly disposed of.

Further personal measures are:—

- (1) To wear slacks after sundown.
- (2) Not to bathe after dusk.
- (3) Not to leave rubbish about or spill water on the ground.
- (4) To use sand-fly proof nets 45 meshes to the square inch around their beds.
- (5) To use repellants such as camphor in their beds.

Natural air-currents must be fully utilised, and a liberal supply of electric fans or punkahs provided.

That a considerable reduction in the phlebotomus incidence can be

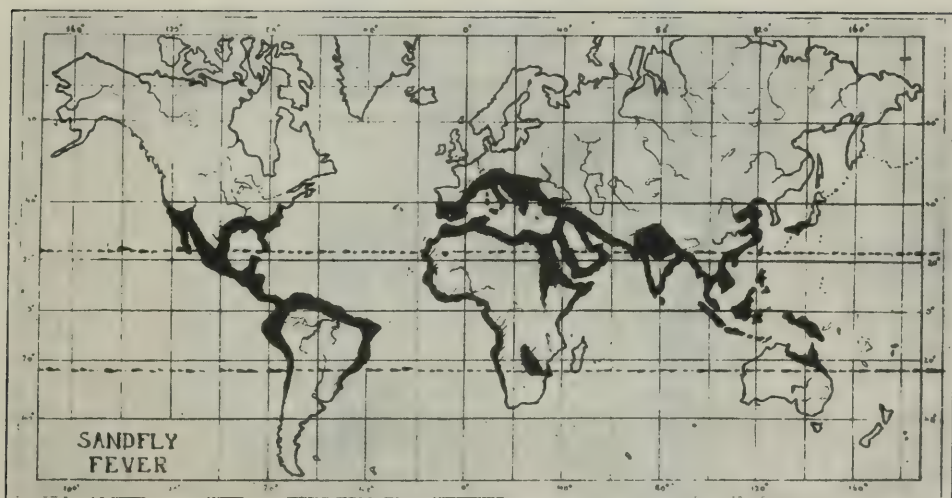
obtained by the prophylactic measures detailed above is borne out by the results obtained at Calafra. Here the case incidence of phlebotomus fever in 1922 was half that in either of the two preceding years.

ACKNOWLEDGEMENTS.

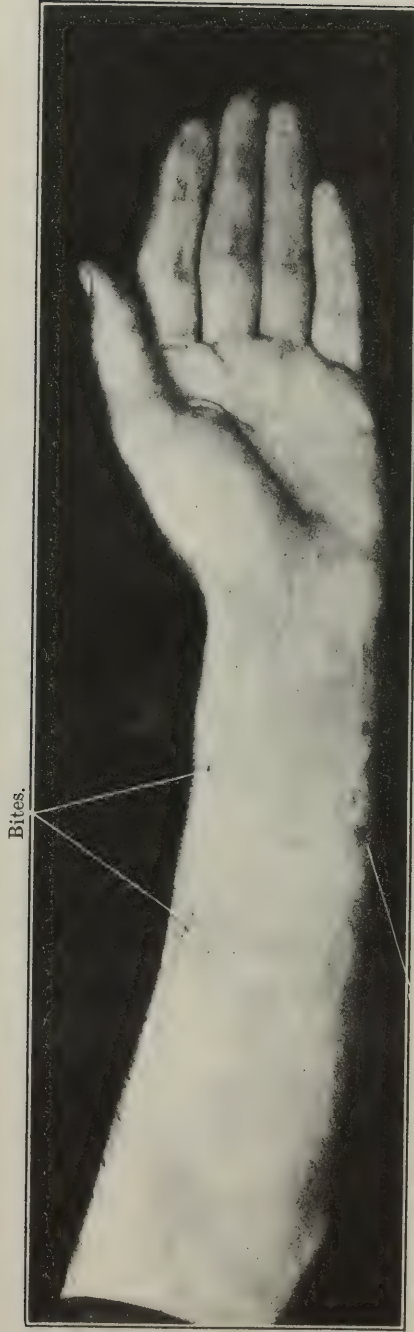
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GEOGRAPHICAL DISTRIBUTION OF SANDFLY FEVER.



Bites.

PHOTOGRAPH 1. BITES OF PHLEBOTOMUS PAPATASI.

This photograph shows condition of arm 24 hours after bites were inflicted.

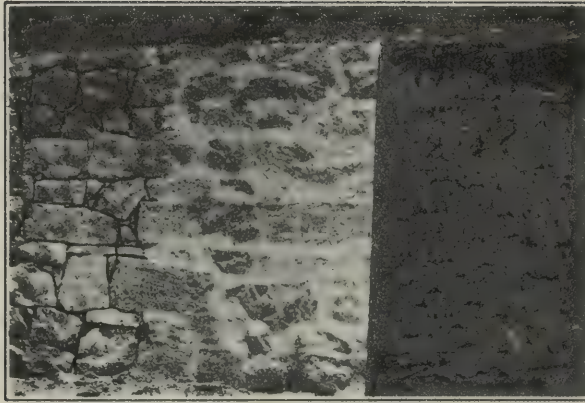


PHOTOGRAPHS 2 AND 3. LEVELLING OF GROUND SURFACE.

In Photograph 2 the broken surface of the ground is shown. All hollows are being filled in with road metal and the whole surface is being consolidated by a heavy roller. Photograph 3 shows the ground surface after levelling, rolling and tarring.

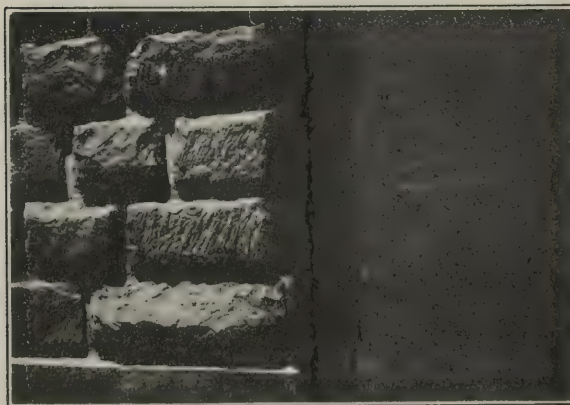
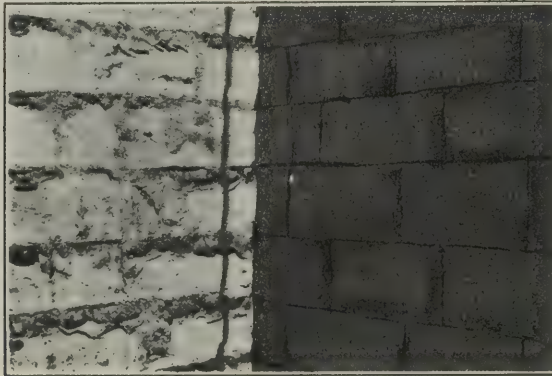


PHOTOGRAPH 4. FACING OF WALLS AND EMBANKMENTS.



PHOTOGRAPH 5. POINTING AND PRESERVING WALLS.

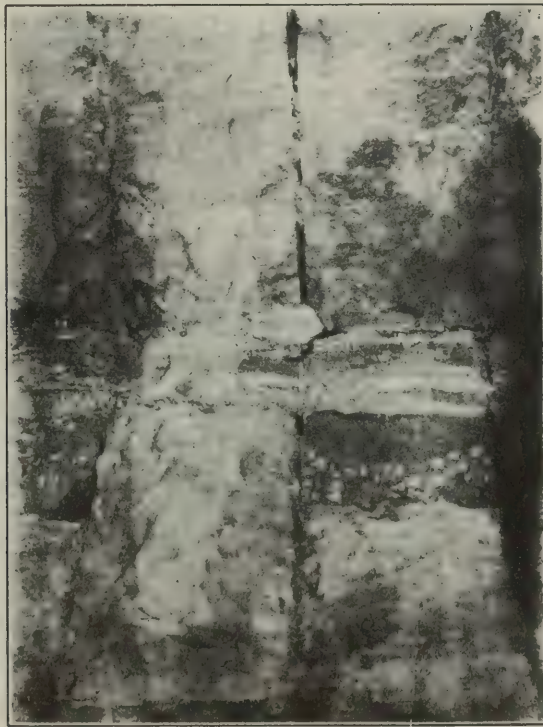
The Photograph shows to the left the loose nature of the wall before treatment, in the centre the careful pointing, and to the right the tarring of the wall to preserve its surface.



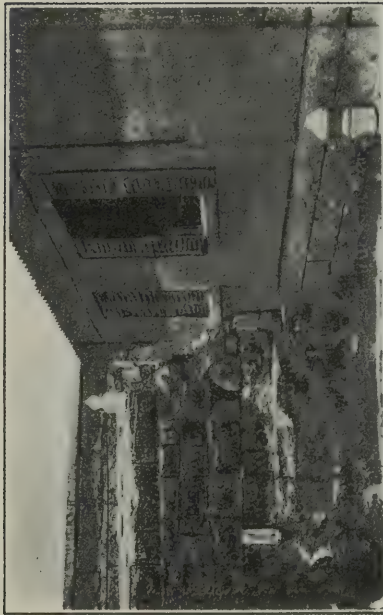
PHOTOGRAPHS 6 AND 7. POINTING OF BUILDINGS.

Photograph 6 shows the faulty pointing of the walls of a building.

Photograph 7 shows the correct method of pointing walls.



ENLARGEMENT OF PHOTOGRAPH 6 SHOWING APERTURES IN THE WALL.



PHOTOGRAPH 9. EROSION OF WALLS.

This Photograph shows the erosion of the lower parts of walls. The dampness and erosion of the lower three feet of the walls of buildings is well seen. Such eroded walls afford shelter for phlebotomi.



PHOTOGRAPH 10. REMOVAL OF INSANTARY BUILDINGS.

This Photograph shows an old wooden hut erected in the midst of rubble ground, acting as a shelter for phlebotomi and interfering with the proper levelling of the ground surface. It is interesting to compare this photograph with Photograph 4 showing the same area after the hut had been demolished and the bank faced.



PHOTOGRAPH 11. MEYER'S KNAPSACK SPRAYER.

The various parts of the sprayer are well seen. Note the length of the pressure tubing connecting the reservoir and nozzle; this length of tubing makes the spraying of all parts of any building easy with the minimum of transportation of the reservoir.



PHOTOGRAPH 12. DISPOSAL OF WASTE WATER.

Photograph shows a gully, not properly aligned, the result being that surface water collected and rendered the lower part of the adjoining embankment damp. This embankment formed an ideal breeding ground for phlebotomi.



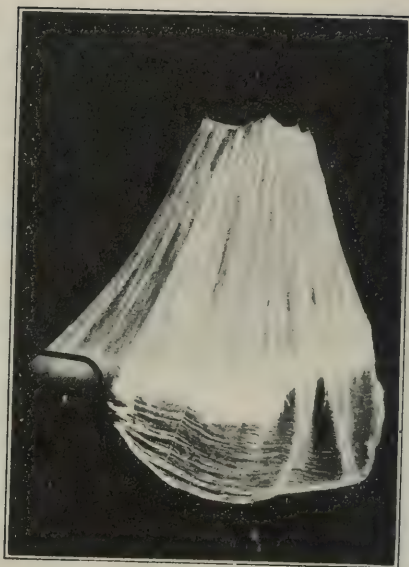
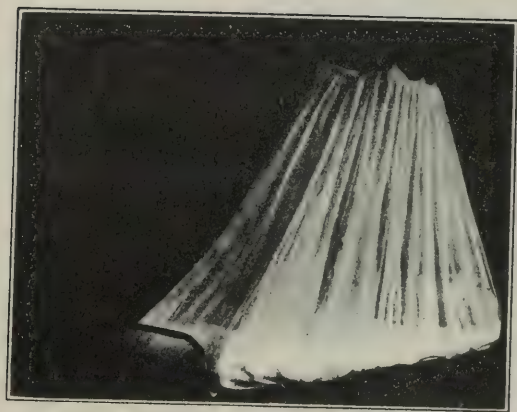
PHOTOGRAPH 13. BREEDING GROUNDS OF PHLEBOTOMI.

Photograph shows muslin cages, especially constructed to trap phlebotomi, at various levels of an old wall. Cages were erected so as to trap any phlebotomi breeding out from 1st, 2nd, 3rd or 4th foot of the wall. The only level from which phlebotomi were trapped was from the lower foot, these apparently came from the garden soil.



PHOTOGRAPH 14. BREEDING OF PHLEBOTOMI.

Cages in which phlebotomi were collected as they bred out of garden soil.



PHOTOGRAPHS 15 AND 16. PHLEBOTOMUS-PROOF NETS.

Photograph 15 shows how a phlebotomus-proof net should be tucked in before sunset.

Photograph 16 depicts the wrong way of using such a net.

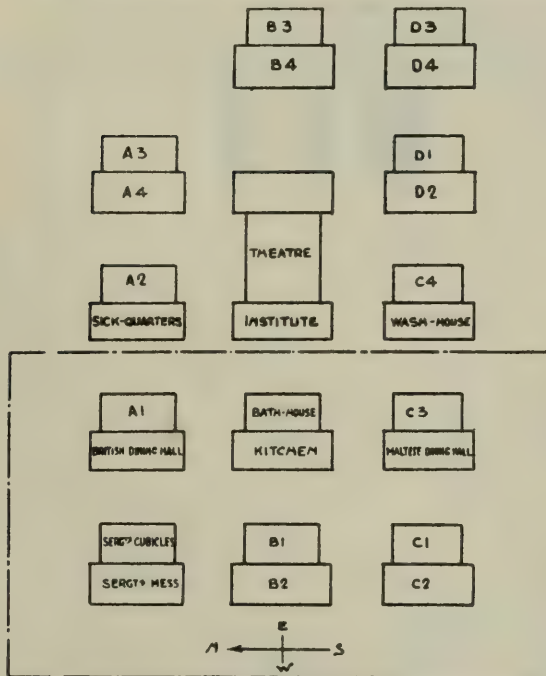


PHOTOGRAPH 17. AIR SPACES BETWEEN HUTS.

This photograph shows that the distance between the huts is only equal to the height of the buildings, and the various annexes prevent the free circulation of air-currents.

Walking stick in foreground measures 3 ft. in length, the height of officer from ground level to top of topi is 6 ft.

CHART 1.—PLAN OF R.A.F. CAMP. 267 SQUADRON, CALAFRANA CAMP.

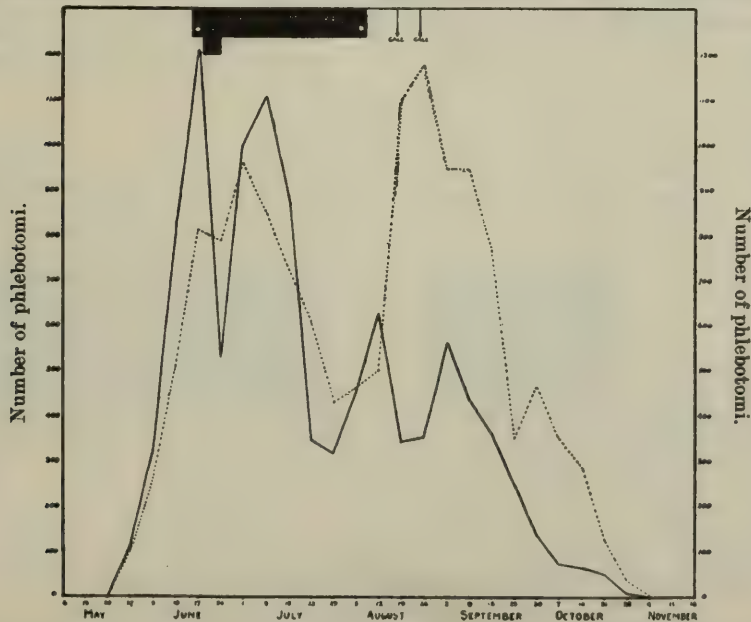


Broken Line Border represents western half of Camp, which was specially treated to abolish the breeding-grounds of Phlebotomi.

The Eastern portion of the Camp did not have the ground, buildings or walls specially treated.

The Upstairs Huts are shown as small rectangles mounted on top of larger rectangles which represent the Ground-floor Huts.

CHART 2.—SHOWING THE EFFECT OF PROPHYLACTIC MEASURES DIRECTED AGAINST THE BREEDING-GROUNDS OF PHLEBOTOMUS IN THE DIRECT VICINITY OF THE MEN'S QUARTERS.



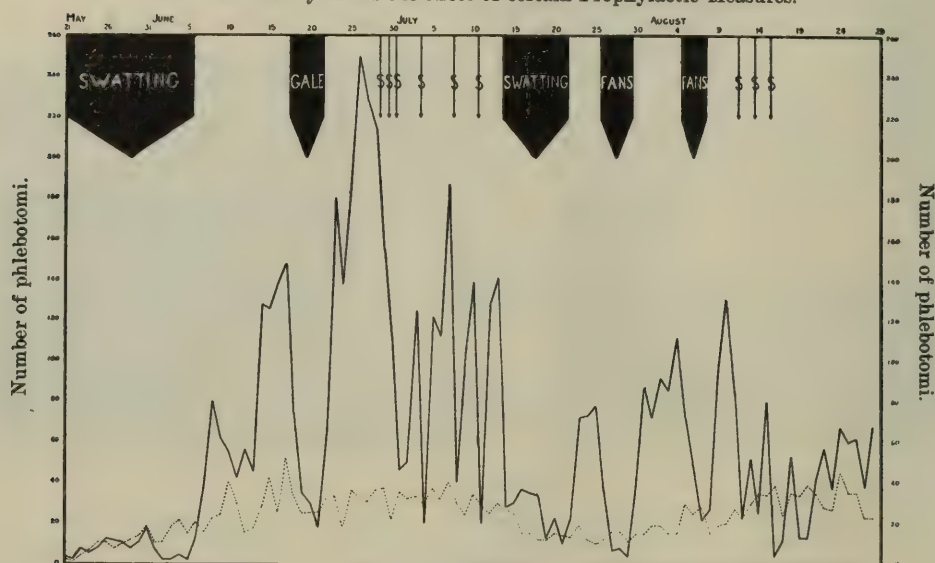
The Continuous Line represents the weekly total of Phlebotomi in the Treated Half of the Camp.

The Broken Line

Untreated Half of the Camp.

CHART 3.—SHOWING THE INCIDENCE OF PHLEBOTOMUS AT THE ROYAL AIR FORCE STATION, CALAFRANA, DURING THE SUMMER, 1922.

This Chart clearly shows the effect of certain Prophylactic Measures.



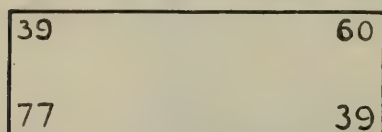
S.—Spraying.

The Phlebotomus Incidence in Hut A4 is represented by the continuous line.

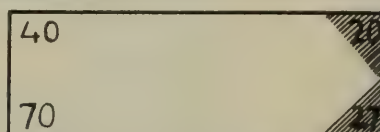
The average Phlebotomus Incidence in five huts strictly comparable to Hut A4, but which were swatted daily, is represented by the dotted line.

CHART 4.—DIAGRAM SHOWING THE EFFECT OF CRESOL SPRAYING ON THE INCIDENCE OF PHLEBOTOMI IN BUILDINGS.

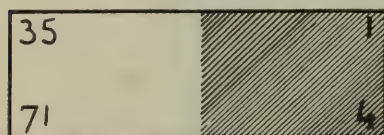
The numbers inside the rectangles represent the phlebotomi in the corner of the hut indicated.



I.—28.6.22. 7.30 p.m. Condition of hut prior to spraying.



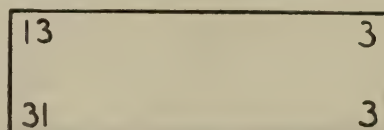
II.—29.6.22. 7.30 p.m. Two corners of hut (shaded) were sprayed with 1% cresol solution 24 hours previously.



III.—30.6.22. 7.30 p.m. Half of hut (shaded) was sprayed with 1% cresol solution 24 hrs. previously.



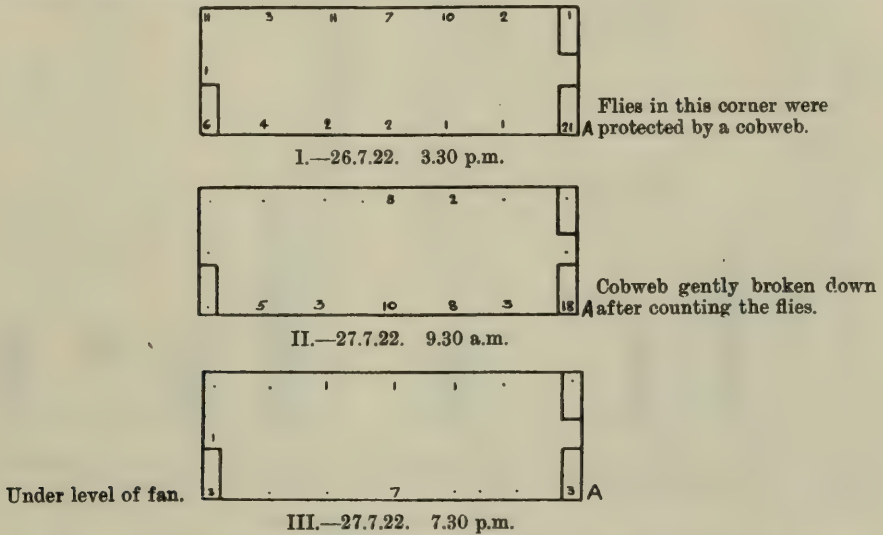
IV.—1.7.22. 7.30 p.m. Whole hut (shaded) was sprayed with 1% cresol solution 24 hrs. previously.



V.—2.7.22. 7.30 p.m. Condition of hut 48 hrs. after last spraying.

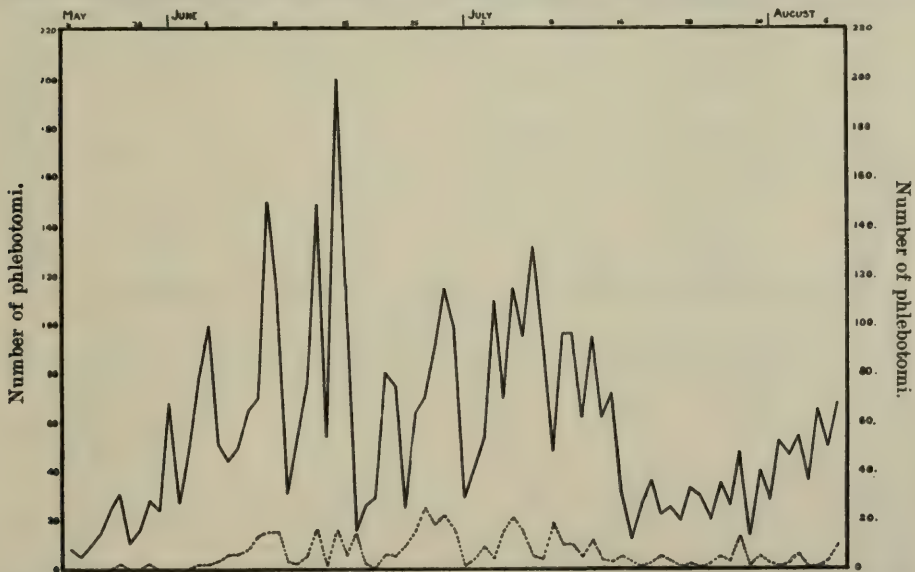
CHART 5.—DIAGRAM SHOWING THE ACCUMULATION OF PHLEBOTOMI IN CORNERS OCCUPIED BY COBWEBS, AND THE DISPERSAL OF THE FLIES WHEN THE COBWEBS WERE BROKEN.

Observation made during experiments with small fans. The figures inside the rectangles refer to the number of phlebotomi in the part of the hut indicated.



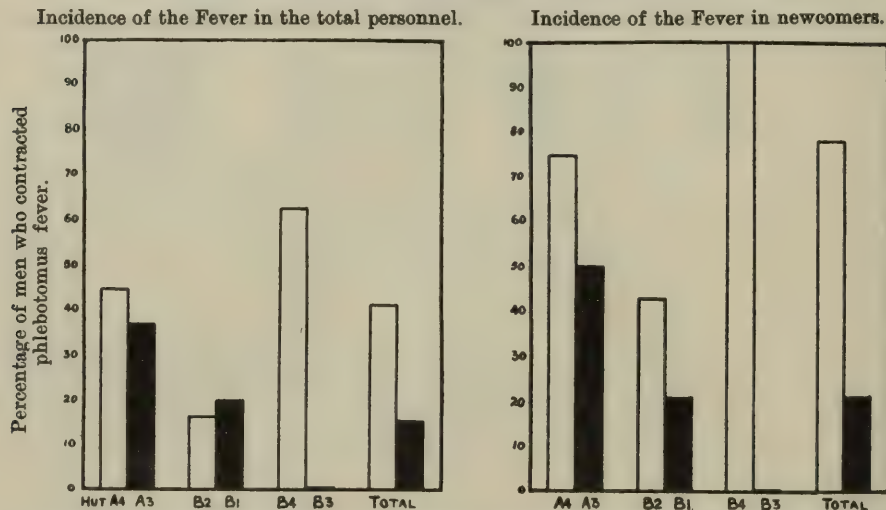
Note the dispersal of the phlebotomi from the corners of the hut except from corner A (*cf.* figures I and II). After the removal of cobweb in corner A the flies were soon dispersed.

CHART 6.—SHOWING THE INCIDENCE OF PHLEBOTOMI IN DIFFERENT STOREYS OF BUILDINGS.



The total number of Phlebotomi in two ground-floor huts, B2 & C2, represented by the continuous line. The " " two first floor huts, B1 & C1, " " broken line.

CHART 7.—DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGE OF CASES OF PHLEBOTOMUS FEVER OCCURRING IN UPSTAIRS AND GROUND-FLOOR HUTS.



The shaded columns represent the percentage of men in upstairs huts who contracted phlebotomus fever; the clear columns represent the men on the ground-floor of the same huts who contracted the fever.

CHART 8.—FAN EXPERIMENTS.
PLAN OF HUT A4, R.A.F. STATION, CALAFRANA, MALTA.
AIR CURRENTS PRODUCED BY FANS.

1. Outer ring of figures = comparative force of air currents one foot from ceiling.
2. Inner ring of figures = comparative force of air currents at level of head of bed.

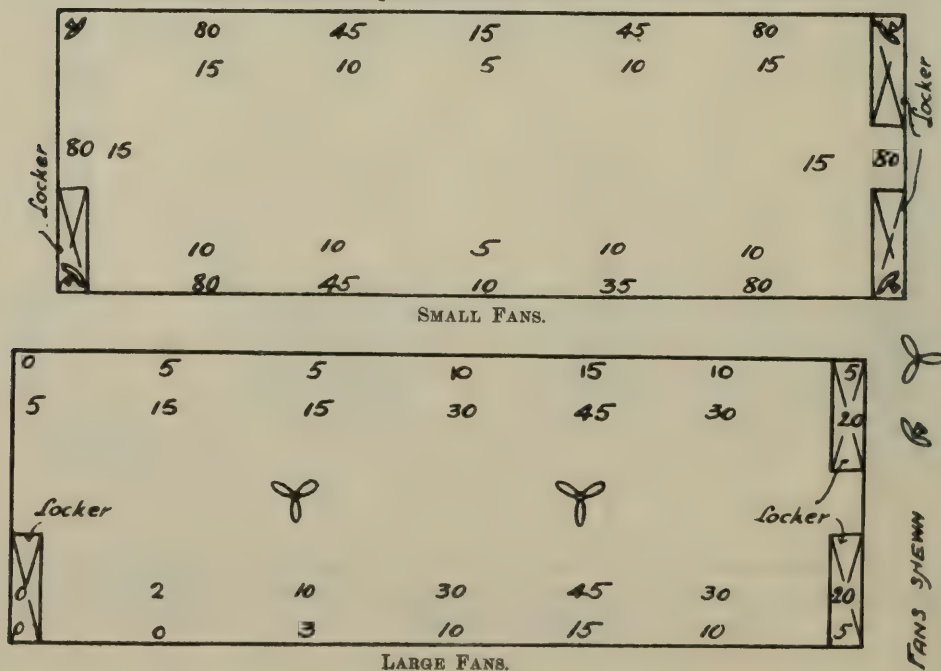
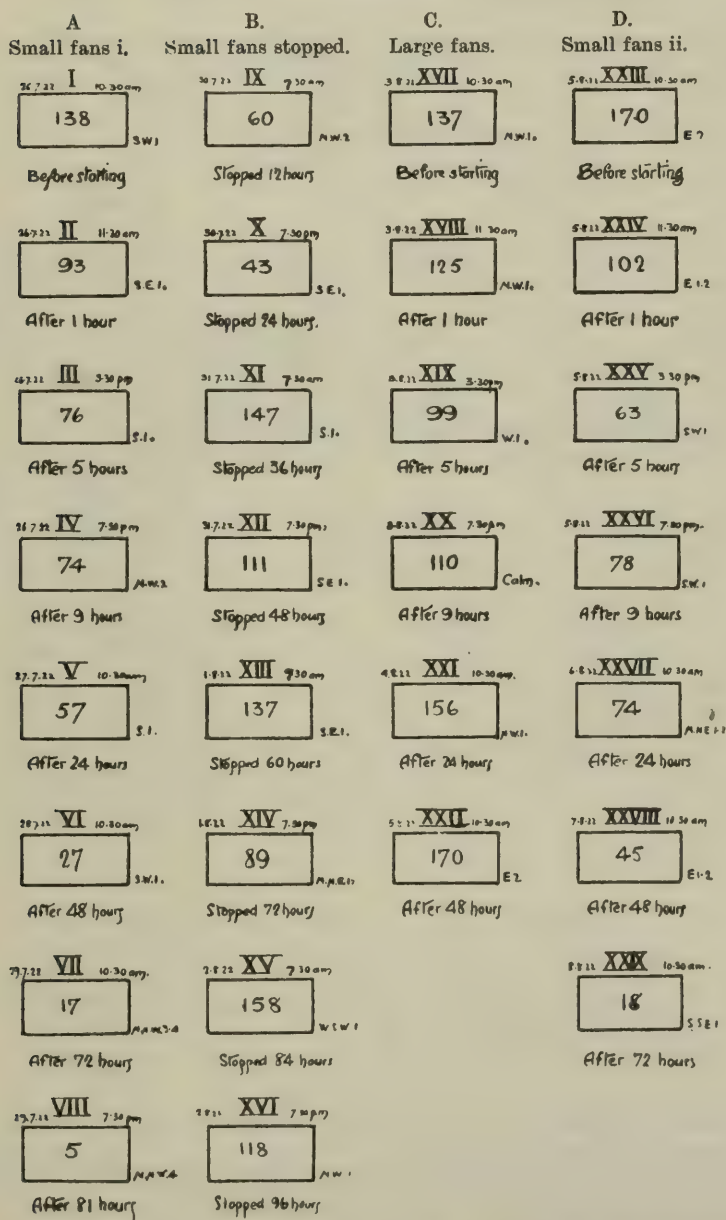


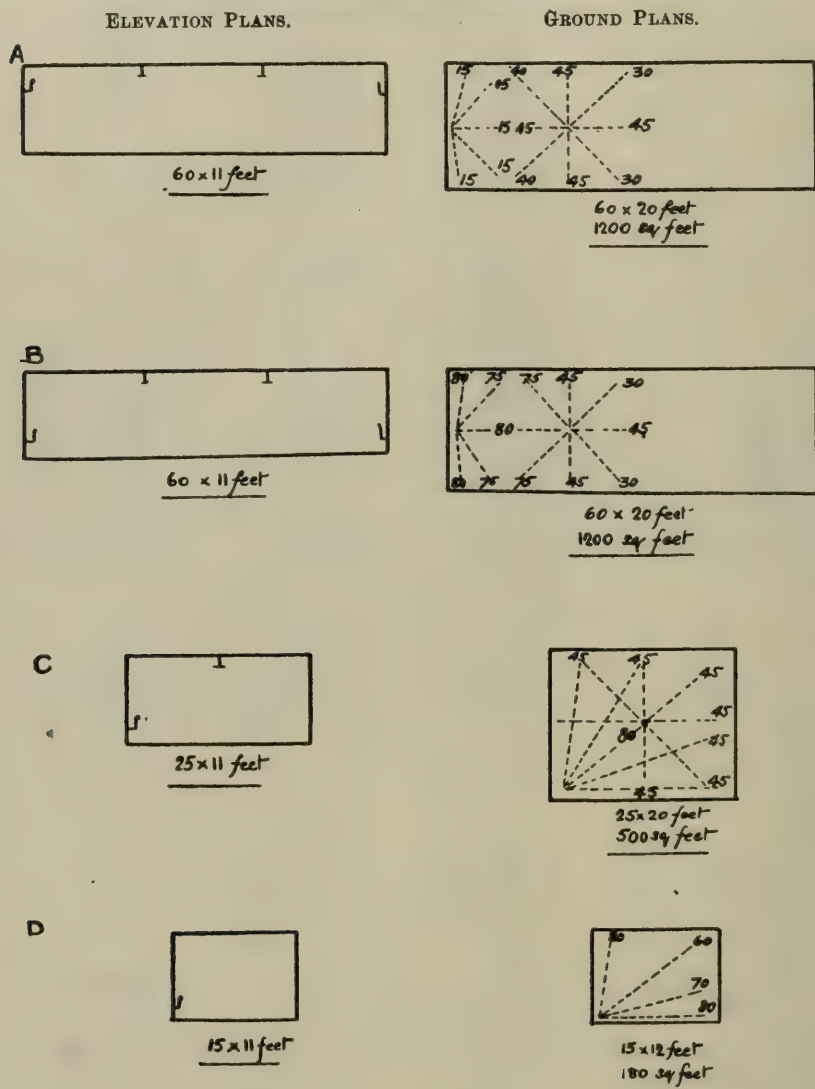
CHART 9.

FAN EXPERIMENTS.



EXPLANATORY NOTE.—The large figures refer to the total number of phlebotomi counted in hut. Letters and figures on the right of each diagram, i.e., S.W.1., refer to the direction and force (Beaufort Scale) of the wind.

CHART 10.—DIAGRAMMATIC REPRESENTATION OF THE POSITION AND RADIUS OF ACTION OF ELECTRIC FANS IN ROOMS.



A.—Shows the position and radius of action of electric fans placed in the upper part of a room with a floor area of 1,200 square feet.

B.—Shows the position and radius of action of electric fans when two oscillating fans are placed in the lower level of room with a floor area of 1,200 square feet.

C.—Shows the position and radius of action of the electric fans recommended for a room of 500 square feet floor space.

D.—Shows the position and radius of action of one oscillating fan in a room of 180 square feet floor space.

A NOTE ON THE TREATMENT OF ULCUS TROPICUM.

By E. J. PAMPANA, M.D.

Though the etiology of *ulcus tropicum* is still obscure, by far the most interesting point for the practitioner in the tropics is the actual treatment of the disease, which is very persistent, and does not respond to the common methods of treatment in out-patients practice.

The treatment of tropical ulcer may be either surgical or medical, but none of the methods which has been advocated is entirely satisfactory. Protargol ointment has given good results and causes no pain but it is rather expensive, as the ointment should contain a large amount of the silver proteinate (CASTELLANI).

I have tried several of the recommended lines of treatment during about two years of practice in Tropical America (Colombia). Besides treating cases of *ulcus tropicum* with formalin, with hypochlorite derivatives, with protargol, bismuth, etc., I have also tried other methods, such as the passive stasis of BIER, the sun treatment, and, finally, acriflavine, which was used during the war. After a series of cases treated with a solution 1/1000 of the last-named drug, I was so satisfied that I decided to test its efficiency more carefully.

I chose six different cases, in similar conditions of general health, all negro labourers and wood-cutters, who could all attend as out-patients and continue their work. Each was affected on a lower limb with a single ulcer which was typical and well developed, and showed numbers of spirochætes and fusiform bacilli. With the exception of one case, which was worse than the others and had an ulcer measuring about 6 cms. in diameter, all the ulcers had a diameter of about 3 cms.

Of these six cases, the first, with an ulcer in the region of the malleolus externus of several months' standing, was treated by simple curetting and then with lysoform, 10 per cent. Notwithstanding the severe pain, the treatment was continued, and after three weeks the ulcer developed a good granulating surface. The ulcer of the second case was similar to that of the first. It was likewise subjected to curetting and then was irregularly treated with lysoform and washings of H_2O_2 . Good granulations did not appear till after the expiry of four months. In the third case, I dealt with an ulcer, three weeks old, on the middle third of the leg. It was first treated with iodoform and then with lysoform. Cicatrisation only began after four months. In the fourth case there was a two weeks old ulcer, which, after curetting, was treated with protargol ointment, 10 per cent. The sore turned into a good granulating surface after three weeks.

The fifth and sixth cases were then treated with a 1/1000 solution of acriflavine. The former had an ulcer on the anterior aspect of the ankle, three months old. Twenty-four hours after the first dressing, a noticeable diminution of the fusiform bacilli and still more of the spirochætes in the pus was observed, while the leucocytes were more numerous and in better condition. In films made on the fifth day of treatment bacilli and spirochætes were rare; on the seventh, neither in the pus nor in the scrapings from the granulations could any spirochæte be found; while very few bacilli still persisted, and the leucocytes appeared perfectly healthy. On the seventh day of treatment with acriflavine, good granulations had filled the ulcer, and a week later the epidermis was almost complete.

The sixth case had a horrible-looking ulcer, almost a year old, on the anterior region of the foot and leg; it was about 6 cms. in diameter. After daily dressing with acriflavine, for three days, a decrease in the number of spirochætes was noticed. After three weeks the whole sore was granulating except for a little sinus at its lower corner, in which the scanty discharge still showed rare fusiform bacilli and spirochætes. After a further three weeks, however, the whole surface was nearly completely invested with epidermis.

In all six cases the dressings were renewed daily until good granulations had filled the cavity, after which they were dressed every other day. The two cases treated with acriflavine here described, as well as all my other cases treated by this method, were not subjected to any curetting, while the application did not cause the least pain.

Smears from the pus of all these tropical ulcers showed great numbers of organisms belonging to the symbiosis fuso-spirillaris of VINCENT. It is well known that an etiological value has been attributed to this group of organisms in the tropical ulcer, although the chief support of this hypothesis is only the very frequent coincidence between this group of organisms and the disease. Now, *ulcus tropicum* is defined as an ulceration of circular or roundish outline, with borders not inflamed, only slightly or not at all raised and neither ragged nor undermined, but sloping down towards the centre of the ulcer, which is thus conical in shape; the base of the ulcer is covered with necrotic material emitting a foul smell, while there is sometimes a tendency to phagedænisism.

With one exception all ulcers of this type which I have examined have revealed spirochætes and fusiform bacilli of VINCENT.

I can recall two cases of torpid wounds which developed into a specific ulceration having none of the characters of *ulcus tropicum*, and which, as a matter of fact, were quickly amenable to a simple iodoform treatment. They both showed spirochætes and fusiform bacilli which appeared to be the same organisms as those occurring in true *ulcus tropicum*, as far as simple microscopic examination could determine.

Supposing these organisms to be the same as those of *ulcus tropicum*, their presence in these aspecific ulcerations requires some explanation in the light of several reported failures to inoculate the disease. It is possible that the organisms may be necessary, but not sufficient alone to produce the disease, which requires the co-operation of some other factor. As regards the

inoculability of *ulcus tropicum*, I was able to attempt an inoculation, unluckily unique, in a voluntary subject whom I chose because he was already suffering from a lacerated and bruised wound which was very torpid, on the posterior region of the ankle. This wound, on repeated examinations, was shown not only to be free of spirochætes or fusiform bacilli, but no organism whatever could be found at the microscopic examination. Under the undermined borders of this wound, already several days old, I inoculated a little pus taken a few minutes before from a tropical ulcer, very rich in spirochætes and fusiform bacilli. I dressed the wound aseptically afterwards and for about a week no change was noticed. The patient then left, and only came to me again twenty-nine days after the inoculation. He had at this time a typical tropical ulcer in the place of the former wound, and the very first smear showed numerous spirochætes and fusiform bacilli. The ulcer healed subsequently rather quickly under an acriflavine treatment.

The result obtained by this single attempt at inoculation may be a small contribution to our knowledge of tropical ulcer, though it must be admitted that the experiment was carried out in an endemic zone. It tends to confirm once again the correlation between *ulcus tropicum* and *symbiosis fuso-spirillaris*; but it cannot be taken as a conclusive demonstration of the etiological significance of these organisms.

CONCLUSIONS.

1. For many cases of *ulcus tropicum* in Tropical America, the daily application of a damp dressing of 1/1000 acriflavine has proved to be the most efficacious, economical, practical and painless treatment.

2. A single inoculation of the pus of a tropical ulcer containing spirochætes and fusiform bacilli into a torpid wound, was followed a month later by its transformation into an *ulcus tropicum* showing the *symbiosis fuso-spirillaris*.

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Archiv für Schiffs- und Tropenhygiene. 1922-1923.
Annales de la Soc. Belge de Med. Trop. 1922.

ORIENTAL SORE IN PALESTINE, WITH A REPORT OF A NEW ENDEMIC FOCUS.

BY

I. J. KLIGLER, M.A., PH.D., B.Sc.,

Controller, Malaria Research Unit, Department of Health, Palestine.

Palestine is known as one of the countries where oriental sore is endemic. The local form of cutaneous leishmaniasis is called Jericho boil, because the infection was believed to be localized in that city. In the past two years we have had occasion to see a number of patients, who have contracted their infection in the vicinity but outside the limits of the city of Jericho, and recently we have studied three cases who have apparently acquired the disease in Kantara, on the southern border of Palestine.

The object of the present note is to describe briefly the cases of oriental sore from Kantara, and compare their lesions with those of Jericho boil studied in this laboratory.

ORIENTAL SORE IN KANTARA.

History of Cases.—Towards the end of the year 1922, the personnel of the railway stores was transferred from Kantara to Haifa. During the latter part of January two adults and an infant were sent to the laboratory with sores suggestive of leishmaniasis. Examinations of scrapings from the sores revealed the presence of typical leishman bodies. The following is a brief description of the cases.

Case 1.—Abdul Malik, 25 years old, works in the railroad stores and was stationed in Kantara. During the last year he left Kantara only once, when he went to Cairo. He was transferred to Haifa two months prior to examination. One month after his arrival in Haifa, three sores developed, two on the finger joints and one on the right cheek, over the cheek bone.

On 17th January, he came to the laboratory. He related that he had already received five emetin injections from the Medical Officer of the railroad. The sores on the finger joints were healed, but the one on the cheek was still active.

The picture of the sore was quite typical. It was elevated, glossy, the base red, the top covered by a dry crust and the area around the sore indurated. There was no pain or sensitiveness. Smears were made from the granulation tissue and stained with Giemsa. On examination, typical leishman bodies were found, enclosed in large mononuclear cells.

Case 2.—Kamil Massif, 27, also an employee in the railroad stores. He was stationed in Kantara until a month prior to the examination, when he was transferred to Haifa. During the three years that he was in Kantara he left only once; one month prior to his transfer he went to Safin-El-Kun, near Tanta, Egypt.

Ten days before his examination in the laboratory, or about three weeks after his arrival in Haifa, he developed a sore on the right cheek over the cheek bone.

The patient came to the laboratory 22nd January. He had received no treatment. The sore was typical and still fresh and active. The smear revealed large numbers of large mononuclears with leishman bodies, as well as occasional free forms.

Case 3.—Zizif Golas, 5 months old. The father is an employee in the railroad stores and was stationed in Kantara. The mother went to Cairo to be delivered, and about a week after delivery returned to Kantara. The father had no sores. The mother had a number of non-characteristic sores on her face and body, and on examination no leishmania were found.

The family came to Haifa two months prior to the examination and about one month after the arrival the child developed a sore in the inner corner under the left eye.

The child was brought to the laboratory on 28th January. Smears were made and typical leishman bodies were found profusely distributed throughout the smear.

The histories of these cases indicate that the infection was contracted in Kantara. Although all the patients had been away from Kantara for short visits to Egypt, the fact that they visited different cities not known to be centres of infection renders it unlikely they had received their infection in Egypt. Another important consideration is the fact that the sores developed only after the patients had been in Haifa for some time. This corresponds with the experience with Jericho boil, which usually develops some time after the patient has left the endemic area.

It is quite likely that other instances of infections at Kantara have been noted before. No literature being available, Dr. STUART has kindly communicated with Dr. RICHARDS, in Egypt. In reply he writes: "I know that during the war, and after it, there was quite a number of cases of *Leishmania tropica* among the British troops, particularly at Kantara." If that was the case, there is little doubt that Kantara is an endemic centre of oriental sore.

CHARACTER AND DISTRIBUTION OF BOILS.

The sores were always found on the exposed parts of the body. All of the patients, from Jericho as well as from Kantara, had sores on some parts of the face. The face is apparently the place of choice for these.

On comparing the sores from the two sources, certain differences were noted. The Jericho sores were multiple in character. Four of the five cases seen had one or more sores on some exposed part of the body (hand or feet) in addition to the one on the face. The Kantara sores were, on the other hand, unitary; only one patient had more than one sore. The Jericho sores were

nodular and discrete and the surface smooth and glossy. The Kantara sores were flat, spreading, and the tops covered with a dry crust.

The most striking difference between the sores from the two sources, was noted in the number of parasites. In the Jericho sores the leishman bodies were few in number, difficult to find, almost invariably intracellular. In the Kantara sores, on the other hand, the parasites were abundant, and both extra and intracellular forms were found with ease in considerable numbers. In the smear from the infant, the free parasites were so numerous that it looked like a generalised infection.

It is difficult to fix the incubation period, but from the cases observed it is possible to fix maximum and minimum limits. The patients who contracted the infection in Jericho were there during the months of July to September, and began to come for treatment in November: The maximum period between the visit to Jericho and the appearance of lesions was four months. In one instance, the lesion appeared two months after the arrival and one month after leaving Jericho, giving a maximum and minimum incubation of two months and one month respectively.

The only one of the Kantara cases in which the incubation limit can be defined, is the infant. In this case it was two months.

As far as could be determined there were no noticeable differences in the parasites. Cultures were easily obtained in the media described in a previous publication, but infection of lower animals was not successful.

SUMMARY.

There are apparently two endemic foci of oriental sore in Palestine. One is Jericho and its vicinity down to the Dead Sea, the other is Kantara. There are certain differences in the character of the boils derived from the two localities. The Kantara boil bears a closer resemblance to Aleppo or Delhi boil than to that of Jericho. The parasites found in the boils from these two localities are identical, so far as one can judge from cultural and morphological characteristics.

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PATRONAGE OF H.M. KING GEORGE V.

At the Laboratory Meeting, held at the London School of Tropical Medicine, on 13th December, the President had the privilege of announcing that he had received a letter, dated 11th December, informing him that H.M. the King had been graciously pleased to become Patron of the Society. This communication was received with great satisfaction by all the Fellows and visitors present. A letter expressing appreciation of the honour conferred upon the Society was sent in acknowledgment.

The Society is indebted to the President, Surgeon Rear-Admiral Sir PERCY BASSETT-SMITH, K.C.B., C.M.G., and Dr. A. G. BAGSHAWE for bringing the Society to the notice of His Majesty, who, in conferring upon it this honour, has given a further recognition of its importance.

NEW FELLOWS.

The following were duly elected Fellows of the Society on the 15th November, 1923 :—

- ANDERSON, Capt. LAURENCE A. P., M.A., M.D., B.Ch., D.T.M. & H., I.M.S.
 ANIGSTEIN, LUDWIK, M.D., Ph.D. (Heidelberg), Warsaw, Poland.
 BASU, Capt. PHANINDRA NATH, M.B. (Cal.), D.P.H. (Lond.), I.M.S.
 BHANDARI, Capt. M. G., M.B., B.S. (Punjab), I.M.S.
 BRAMHALL, Lt.-Col. CHARLES, O.B.E., M.R.C.S., L.R.C.P. (Lond.), London.
 BROWN, DAVID M., M.D., C.M., Tanganyika Territory.
 CARLEY, PAUL S., A.B., B.S., M.D., Department of Health, Jerusalem.
 CHARTRES, EDWARD A., F.R.C.S., F.R.C.P., D.P.H., England.
 CHRISTOPHERS, Lt.-Col. SAMUEL R., C.I.E., O.B.E., I.M.S.
 COOKE, FRANCIS H., L.R.C.P. & S. (Ireland), L.M., Gold Coast.
 DAS, Capt. HARI, M.B., B.S. (Lond.), M.R.C.S., L.R.C.P. (Lond.), I.M.S.
 DUNSCOMBE, WILLIAM K., M.D., B.S. (Durh.), M.R.C.S., L.R.C.P., England.
 FINDLAY, Capt. JAMES, M.A., M.B., Ch.B., I.M.S.
 GIBSON, ERNEST, M.C., L.R.C.P. & S.E., L.R.F.P.S. (Glas.), Irish Free State.
 GIVEN, Surg.-Comdr. D. H. C., M.B., B.Ch., D.P.H., Singapore.
 HEARNE, ARTHUR A., M.B., Ch.B., D.P.H., Jamaica.
 HENNESSY, DAVID R., M.B., Ch.B. (Trin. Coll., Dublin), Malaya.
 HUTSON, JOHN, M.B., C.M. (Edin.), D.P.H. (Cantab.), Barbados.
 KHAREGAT, Capt. RUSTAM M., M.B. (Lond.), M.R.C.S., L.R.C.P., I.M.S.
 KINGSBURY, A. NEAVE, M.B., B.S., B.Sc., M.R.C.S., L.R.C.P., D.P.H., D.T.M. & H., Singapore.
 LEONARD, Lt.-Col. THOMAS M. R., D.S.O., L.R.C.P. & S.E., L.R.F.P.S. (Glas.), I.M.S.
 McCULLOCH, WILLIAM E., M.B., Ch.B. (Aber.), W.A.M.S.
 McROBERT, Capt. GEORGE R., M.D. (Aber.), M.R.C.P. (Lond.), I.M.S.
 O'BRIEN, HENRY R., M.A., M.D. (Michigan), Assistant Director for Siam, International Health Board.
 PAMPANA, EMILO J., M.D. (Florence), D.T.M. & H. (Lond.), Colombia.
 PATERSON, WILLIAM LYLE, M.C., L.R.C.P. & S. (Edin.), L.R.F.P.S. (Glas.), Hong Kong.
 SEN, Miss YAMINI, L.R.F.P.S. (Glas.), D.P.H. (Cantab.), L.M., India.
 SHAIK, Capt. ABDUL HAMID, M.B., Ch.B. (Edin.), B.A. (Punjab), I.M.S.
 SHEEDY, FREDERICK J., M.B.E., B.Sc., M.R.C.V.S., Deputy Chief Veterinary Officer, Das-es-Salaam, Tanganyika Territory.
 STEVEN, JOHN BANKS, M.B., Ch.B. (Glas.), Nigeria.
 YOUNG, WILLIAM A., M.B., Ch.B., D.P.H., D.T.M. & H., Lagos.

MOVEMENTS OF FELLOWS.

The following Fellows from abroad have notified the Secretaries that they are at present in the British Isles :—

- BASU, D., India.
 BAXTER, J. B. S., Sierra Leone.
 BLACKLOCK, Professor B., Sierra Leone.

BHANDARI, Capt. M. G., I.M.S.
 BOND, ASHTON, Uganda.
 BOMFORD, Major T. L., I.M.S.
 BOOTH, LIONEL H., Lagos.
 BRAIMBRIDGE, C. V., Kenya Colony.
 BUTLER, G. G., Tanganyika.
 CARTER, Major R. St. M., India.
 CLARKE, J. KILIAN, Egypt.
 CANTLIE, Captain NEIL, Sudan.
 COOK, CECIL E., Queensland.
 COOKE, F. H., Gold Coast.
 COURTNEY, B. J., Nigeria.
 DAS, Capt. H., I.M.S.
 DHAWAN, Captain W. H., I.M.S., India.
 DUNLOP, J., India.
 EARLY, P. V., China.
 EL-KATTAN, M. A., Egypt.
 FAYRER, Lieut.-Colonel F. D. S., I.M.S., India
 FINDLAY, Capt. J., I.M.S.
 FOOTNER, G. R., Sudan.
 FORDE, J. R., Gold Coast.
 GILMORE, H. C., Congo Belge.
 GOODBODY, Colonel C. M., Southern Rhodesia.
 GRAHAM, Lieut.-Colonel J. D., Iraq.
 GRAY, GEORGE M., Nigeria.
 GREIG, Lieut.-Colonel E. D. W., I.M.S., India.
 GRIEVE, K. K., Nigeria.
 HAMILTON, Lieut.-Colonel W. HAYWOOD, I.M.S.
 HARPER, F. S.
 HARPER, FRANCES M., Congo Belge.
 HEARNE, A. A., Jamaica.
 HOOPS, A. L., Singapore.
 KEIGWIN, G. J. W., Gold Coast.
 KHAREGAT, Capt. R. M., I.M.S.
 MARTIN, Captain C. DE C., I.M.S.
 MORRISON, M., North Nigeria.
 NUNAN, P. F., Kenya Colony.
 OGILVIE, Major-General W. H., India.
 PEAKE, E. C., China.
 PEACOCK, Major L. H., Sierra Leone.
 QUIRK, E. J., Nigeria.
 RABAGLIATA, Major D. S., Egypt.
 REID, C. B. B., Kenya Colony.
 RICE, T. E., Nigeria.
 RICHARDSON, BARBARA, India.
 SALAMA, ANIS, Egypt.

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MOVEMENTS OF FELLOWS.—*Continued from page vi.*

SANDISON, Lieut-Colonel J. F. W., Iraq.

SENIOR-WHITE, R., Ceylon.

SIMMONS, R., Gold Coast.

SPEARMAN, B., Zanzibar.

SUTCLIFFE, EDWARD, Gold Coast.

VALENTINE, DOUGLAS J., Hong Kong.

WATSON, MALCOLM, Federated Malay States.

WIGAN, W. C., Nyasaland.

WILKINSON, SYDNEY A., India.

WOOD, G. Y., Sierra Leone.

WRIGHT, R. E., India.

WYNNE, T. G., Australia.

EDITORIAL NOTICES

The Editor of the TRANSACTIONS will be pleased to receive short papers to be included under the heading of "Communications" or "Questions," in addition to longer papers on subjects of Tropical interest, which may be offered for presentation at meetings of the Society. He will also be glad to receive books for review.

Attention is drawn to the rule that Contributors of papers to the TRANSACTIONS receive 25 reprints free of charge, *provided they apply for these when sending the paper.*

Any communication for the Editor should be addressed to THE EDITOR of the TRANSACTIONS of the Royal Society of Tropical Medicine and Hygiene 11, Chandos Street, Cavendish Square, W. 1.

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There are frequent applications for these volumes from Libraries which are desirous of completing their sets. At the present time it is impossible to meet these requests, and it is felt that it would be doing a service to the cause of science to help them as far as possible.

